TECHNOLOGY TRANSFER: A NEW CONTACT SPORT

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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CONTENTS

WITNESSES

	Page
July 8, 1988:	
Jack Keever, Adams County Economic Development Corporation	1
Robert Sievers, Director, Cooperative Institute for Research in Environmental Sciences, University of Colorado	3
Dr. Bruce Mattson, Manager, Technology Commercialization/Small Business Outreach, National Bureau of Standards	4
Jeff Reaves, Senior Contract Negotiator, National Center for Atmospheric Research	7
Dr. Vernon E. Derr, Director, National Oceanic and Atmospheric Administration	8
Dana Moran, Director, Research and Technology Applications, Solar Energy Research Institute	10
Dr. Bob Calcaterra, Director, Research and Development, Adolph Coors Quality Analysis Laboratory	12
David Hirsh, Executive Vice President and Director of Research, Synergen, Inc	18
Dr. James Brown, Assistant Vice President for Research and University Patent Officer, Colorado State University	19
John Cordes, Dean of Graduate Studies, Colorado School of Mines	21
Cary Israel, President, Front Range Community College	23
Donald Hearth, Associate Vice President for Research, University of Colorado at Boulder	25
Jerry Plunkett, Vice Chancellor for Research and Technology, University of Denver	28
Appendix: Additional material submitted for the record	34

TECHNOLOGY TRANSFER: A NEW CONTACT SPORT

FRIDAY, JULY 8, 1988

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in the Coronado Room, Holiday Inn, East 120 Avenue, Northglenn, Colorado, Hon. David Skaggs presiding.

STATEMENT OF JACK KEEVER, ADAMS COUNTY ECONOMIC DEVELOPMENT CORPORATION

Mr. KEEVER. Okay, ladies and gentlemen, let's get started.

My name is Jack Keever and I'm with Adams County Economic Development Corporation, one of your sponsors this morning. But we're here together in kind of a very unique setting with a unique, diverse group.

Those of you in the research community have been talking tech transfer for years. To those of us from the local, civic and economic development community this is a new word for us. So you're going to see different faces participating for, I think, the first time.

This gathering, in my opinion, is unique in the country.

It's a pleasure to ask you to join us—or join me this morning in welcoming our convener, Congressman David Skaggs.

[Applause]

Mr. SKAGGS. Thank you very much. I particularly want to acknowledge the extraordinary help and support that have been given by Jack Keever and Adams County Economic Development Corporation. Cary Israel, where are you?

Cary, the President of Front Range Community College which has just done yeoman duty. Cary and his staff at Front Range preparing the mailings, getting the directory of exhibitors prepared, which will be available to you right after lunch—a whole range of support activities as sponsor of this and remarkably fine job, Cary. Thank you very much. A round of applause for Cary and his colleagues.

[Applause]

And a couple of other people that I want to make special thanks public to. Patricia Laverty who has really been the engineer, on my staff, in pulling all of this together.

Patricia, would you wave? Thank you.

[Applause]

And I will make other comments about some of the other principals in this as we go along this morning.

I really want to start out by saying welcome to an experiment. As far as I know, nothing like this has really been tried. I think it is past time that we try it, but nonetheless, as guinea pigs, if you will, we are all unable to tell you what's going to come out of this.

If we improve communications between the research community and the private business community in any small way, it will be, I think, a big success, and that is really the objective.

I'm very pleased at the number of companies and individuals who registered to participate in this conference, representing a very wide range of interests and products. I think this really confirms the idea that brought about this conference in the first place, that much of the research going on at our colleges and universities and Federal laboratories has direct application to the needs of the business community, and that researchers and business people are increasingly aware of how much they can benefit by collaborating and sharing information with each other.

This hasn't always been the case. Back before 1980, before the Tech Transfer Act was passed, for example, businesses and national laboratories weren't that used to dealing with each other. In fact, the way industry used to regard, I think, a lot of federally-funded research recalls or parallels the story that's often told about the famous physicist, Robert Milligan, that one day his housekeeper answered the phone and said, "Yes, this is Dr. Milligan's home, but he's not the kind of doctor that does anybody any good."

[Laughter]

An old song, familiar to many of you, but applicable nonetheless.

Now technology transfer is becoming a much higher priority at the national laboratories, in Congress and in other areas of publicly-supported research. It's become quite clear, I think, that the labs, private universities, public universities, engaged in federally-funded research have a great deal to offer, a great deal of good to do for the American business community.

Earlier this year the House Subcommittee on Science, Research and Technology held hearings in Denver to study the progress that we have made and the problems that still exist in the area of transferring new technologies and information to business.

That's a Subcommittee on which I sit. I was happy to be able to bring it to Denver to see how we're doing here.

We heard from academics, from financial experts, local business people as well as representatives of many of the local laboratories, and the one conclusion, above all, that came out of this hearing was that those doing research need to do a better job of letting business know what they are doing and businesses need to let the researchers know more completely what they can do to help them.

Better communication is the key between individual researchers and individual businessmen and women. I stress individual. It was made emphatic to us over and over again that institutional communication isn't what it's all about. It's users and researchers talking together.

And that's the goal of our conference today.

One of the witnesses in February put it this way, and I quote, "Technology transfer is a contact sport, unquote." And that's where we derive the aphorism in our bulletin for today's meeting.

There are plenty of contacts for businesses here. I hope everyone has come with a good supply of business cards.

First of all, the speakers this morning will let you know the nuts and bolts of the information that you need to collaborate with or simply to get information from the areas top researchers at our national laboratories, at our colleges and universities.

When these speakers are finished I expect those of you in the business community will be able to say to yourselves, I know whom to call to get results, and I hope all of you who are here with presentations to make are ready to deal with those calls.

Second, the displays that today's conference participants have put up in the adjoining rooms to the rear should get each of you a very concrete and hands-on idea of the research going on at these institutions. You won't just see brochures. You will be able to talk with the people that are doing the work.

For those that seem relevant to your business, please ask, how can I take advantage of what you are doing in your research.

Let me make a brief apology before we go on with the program. The Colorado Advanced Technology Institute, which is a participant today, was not included in our brochure and the original materials on this. I very much regret that. CATI has been a real leader in Colorado in—both with the Legislature and with the business community and with the university community, making the case for building the base in Colorado for improved partnership between research and business.

And finally, a word of additional thanks to two individuals who will be chairing each of our panels who were key help to me in organizing this, members of my Science and Technology Advisory Committee, David Hirsh and Bob Sievers.

Bob will be moderating our first panel, which we'll get on with right away. We need to stay close to schedule, and my time is up.

Bob's impressive resume includes his principal role as Director of the Cooperative Institute for Research and Environmental Sciences at the University of Colorado. He is a Professor of Chemistry there. Member of the National Academy, member of the University Corporation for Atmospheric Research Board, and lists as his specific science interests, atmospheric chemistry and environmental chemistry and a bunch of other things that I can't pronounce very well.

Anyway, a friend and terrific help in this, Bob Sievers.

STATEMENT OF ROBERT SIEVERS, DIRECTOR, COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES, UNIVERSITY OF COLORADO

Mr. SIEVERS. Thank you very much, David.

Colorado is very fortunate, I believe, to have one of the richest concentrations of Federal Laboratories in the country. I think it probably stands second in the country as far as a region that has a large concentration of outstanding Federal Laboratories, and within these, there is some extraordinary research going on.

And I think that those of us who have had a chance to serve on boards of trustees or on advisory committees have always come away very impressed by what's going on and a little frustrated that we didn't know better how to get access to that, how to carry it to the next step, from the fundamental new scientific knowledge into the market place.

And so, we have assembled a group of people who are going to tell us a little bit more about how that might go, and our first speaker today is Dr. Bruce Mattson, who is Manager, Technology Commercialization/Small Business Outreach, the National Bureau of Standards.

And I've asked Bruce to say, in addition, a little bit about what NBS does, to fill us in as far as some of the changes that have occurred in the climate that makes it easier and better as far as accessing the Federal Laboratory work products.

STATEMENT OF DR. BRUCE MATTSON, MANAGER, TECHNOLOGY COMMERCIALIZATION/SMALL BUSINESS OUTREACH, NATIONAL BUREAU OF STANDARDS

Dr. MATTSON. Good morning.

When I told my Washington colleagues I was coming out here to Denver they said, do not mention the Super Bowl, so I won't.

[Laughter]

But, in the course of our conversation—or my conversation today with you I would like to talk to you about NBS technology, how you can have access to NBS technology, plus, also, I want to talk about a couple of the myths that you may have regarding Federal Laboratories.

The first slide, please.

[Slide]

I think when people hear the word "Federal" they have an immediate reaction.

[Laughter]

We are not the IRS. We will not audit your tax returns. We do not have Michael Tyson as our collection agent. In other words, we're relatively approachable sorts. Okay? We do not search, frisk and shoot you in terms of contract. We, at least at the National Bureau of Standards, have reduced those incidences dramatically.

So, I think, view Federal Laboratories as approachable. I think, because they're not, they're often an under-utilized resource and there are lots of opportunities out there.

Second slide, please.

[Slide]

One of the developments recently that has occurred in Congress is the Technology Transfer Act of 1986. The Technology Transfer Act increased the flexibility that Federal Laboratories have in conducting business with industry, U.S. industry.

Particularly, they allow Federal Laboratories to enter into what are termed collaborative research agreements. Collaborative research agreements now allow laboratories to conduct proprietary research with firms and firms in advance can have exclusive license to the results—research results that they obtain.

That's a very significant development as far as interacting with Federal Laboratories. You now can do proprietary research with them, if that is consistent with their mission.

The Federal Technology Transfer Act also says that laboratories cannot put funds into these research—joint research efforts, but that they can contribute labor, equipment, facilities, in-kind resources.

And as a businessman I think you should look at this as a very positive aspect in interacting with Federal Laboratories. You ask yourself, well, what would I spend my funds for if I were doing a joint research project? It would be labor, equipment, facilities.

So, in essence, you as a small businessman or a large business can leverage your research dollars by interacting and utilizing Federal Laboratory knowhow.

A third component of the Federal Technology Transfer Act of 1986 is that it strongly encourages federal researchers to engage in activities that have commercial merit.

So, I think, this is a significant change in how Federal Laboratories can interact with U.S. industry, and I think the business community knows little about and I think this is an opportunity to take advantage of this particular resource.

Next slide, please.

[Slide]

The National Bureau of Standards itself has a long history of collaborating with industry. For decades we have been providing new technologies and providing measurement methods, standards data, and services that further commerce, technology and science within our nation.

People tend to think that the National Bureau of Standards is only weights and measures. It's not. Because we're providing measurement services for technologies, we have to have a very diverse set of technological skills, and as one becomes familiar with the National Bureau of Standards, it's amazing the diversity of technologies and technical talents that are available at the National Bureau of Standards.

Because of the Bureau's long-term relationship with industry, we have a lot of collaborations with industry, numbering over 200 collaborations presently with U.S. industry. This involves—if you look at the 1,300 technical staff that we have at the Bureau, we have roughly 1,000 guest scientists working in collaboration with Bureau scientists. So, it's almost a one-to-one relationship in terms of leveraging National Bureau technology.

Now, as you look at the Bureau—can I have the next slide, please?

[Slide]

As you look at the Bureau, there are several ways that you can interact with the Bureau and take advantage of our technology. Well, there are two ways that you can interact with the Bureau on a technical basis. One, you can take advantage of our technology, and secondly, you can take advantage of our facilities.

If you look at our technologies, you have access through our technologies through collaborative research agreements, which I previously mentioned. You can license the technologies that we have patented and also have the benefit of working collaboratively with

us on collaborative research agreements again to further develop those technologies.

You can talk to our scientists and have the benefit of informal chats on technical problems. I think the Bureau makes itself very accessible through a broad range of means to the industrial community.

You, as a scientist or an entrepreneur or as a large business, may not have the dollars to afford particularly expensive, unique pieces of equipment, and this is another way in which you can take advantage of NBS facilities. We have, in Boulder, two very unique facilities in terms of an antenna measurement facility and biotechnology processing facility that can be made accessible to you as business people.

So, as you look at the Bureau of Standards there are two domains in terms of interaction with the Bureau of Standards.

The next slide, please.

[Slide]

As I said, the Bureau of Standards is more than weights and measures, and when we look at just Boulder technologies, you can see that we have a very broad range of scientific talent ranging from a research emphasis, on superconductivity down to chemical engineering and biotech processing.

This afternoon, in the poster sessions we will have scientists, division managers from each of these technical areas, that you'll be able to talk to, contact, interact with.

Next slide, please.

[Slide]

This is the last slide.

This is how I would suggest interacting with the National Bureau of Standards. In the poster sessions, it's a great place to start one-on-one contacts with our scientific community.

Generally, in the lack of a poster session, you would contact Dr. Robert Kamper—his telephone number is provided there—and he will provide you entre into the NBS Boulder scientific community.

Once you meet the scientific community I think it then behooves you to sit down and explore further discussions with these and I think my two important points here—first, the scientist is a very important contact for you and then, secondly, on your second contact or third contact with the Bureau, bring in the division manager for that particular scientist so he can be included in the discussions as well, and so that no one is surprised.

Later on in the interaction, if there is a need for assistance in setting up the agreement and patenting and licensing and so forth, I can be brought in to facilitate and to help you and the Bureau scientists. I think the result, if you follow these basic points of interacting with the Bureau, will be a solid research collaboration that will benefit your firm and that will also benefit the National Bureau of Standards.

So, in sum, I agree that technology transfer is a contact sport. At the Bureau we try to make it user friendly as well.

Thank you.

[Applause]

Mr. SIEVERS . Thank you, Bruce.

I can offer one testimonial. My students recently were making new superconductor materials and it was not only difficult, but very time consuming to try to set up the equipment that would make certain measurements of magnetization and thanks to Dr. Ron Goldfarb at NBS those were made and gave us the information we needed.

And I think that's one illustration of the sort of thing that you will find. The Federal Labs are much more open than they have been in previous years.

Our next speaker is Jeff Reaves, who is Senior Contracts Negotiator for the National Center for Atmospheric Research.

Jeff.

STATEMENT OF JEFF REAVES, SENIOR CONTRACT NEGOTIATOR, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Mr. REAVES. Thank you, Bob.

As most of you may surmise, the National Center for Atmospheric Research is involved in atmospheric research. We study the earth's atmosphere, weather, climate, solar physics and oceanographic research.

What you may not know is that NCAR is operated by the University Corporation for Atmospheric Research and UCAR is a consortium of 57 degree granting universities throughout the United States and Canada. Our primary mission is to provide large-scale facilities for those universities and the atmospheric science community.

Just recently, in the last couple of years, we have started to reach out to private industry to work with them to provide the results of our research on more wide-scale basis and make it available to the commercial world.

And in that regard, we have recently established the UCAR Foundation, which is a corporate entity in itself that's sole mission is to interface with U.S. industry to provide for the transfer of technology from the NCAR laboratory to private industry.

We also have the corporate affiliates program which also seeks to involve industry with the NCAR scientists and NCAR programs. More information on that will be available to you in the poster session and we'll have a booth set up out back that will have brochures and information that will tell you how you can contact the UCAR Foundation and the corporate affiliates program to make those contacts and find out just what it is that NCAR has in the way of available technology.

In general, our focus has been on licensing our technology to private industry either on an exclusive or a non-exclusive basis.

We also have entered into several collaborative projects with private industry. For instance, we are currently talking to U.S. West Technologies on a program that we call the airport of the future, and this is involved with the new airport that is being designed for Denver where we're providing radar and other instrumentation that will help detect weather patterns, such as low-level wind shears that are responsible for a number of aircraft accidents.

What we're trying to do here is design this airport so that it will become the safest airport in the world, and then, once we're able to

do this, then we will be able to transfer that to other airports that are being built as well as airports in existence.

So this is the type of thing that we're doing, and we certainly encourage each and every one of you to come and talk to us and get the information and the brochures and see what we're doing. We'd be more than happy to discuss the computer software and other technologies that we have available and see if we can't make a fit with what you folks are doing.

Thank you.

[Applause.]

Mr. SIEVERS. Thank you, Jeff.

Our next speaker is Dr. Vernon Derr. Vernon is Director of the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration.

STATEMENT OF DR. VERNON E. DERR, DIRECTOR, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Dr. DERR. Good morning. It's a pleasure to be here this morning.

We have, in the environmental research laboratories of the National Oceanic and Atmospheric Administration, NOAA for short—I've spent many years in the problem of technology transfer and, today, I think, represents for me a highlight of our attempts to do this because we have spent a great deal of effort and time on what has been a very difficult problem in the past.

It's very difficult to provide the communication, to provide the resources that are necessary to transfer research and technology results into the private sector. We've been doing that for a number of years and I'll illustrate that to you in a few minutes.

But let me tell you a little bit about what our laboratories do.

First of all, NOAA is a mission-oriented organization within the Federal Government. It has certain responsibilities, particularly in the area of services to the citizens and to business and industry.

I think NOAA is probably best known to you, both for its successes and its failures, through the Weather Service. The National Weather Service is part of NOAA, but you may not be aware that NOAA also provides services to fishermen through out National Marine Fishery Service. We provide services to ocean activities of all kinds, including mining as well as transport through our National Ocean Services Group.

We provide space services through our Space Environment Laboratory in Boulder, for example, which is an operational space forecast center in Boulder that provides information to companies that are using satellites because of the fact that these satellites are affected by emissions from the sun.

This is becoming particularly important because we're approaching now the maximum in the sun spot cycle. Approximately by 1991 we will have maximum interference from the sun with activities on the earth.

So, there are a whole variety of things that we're involved with. I would say that if you wanted to characterize the efforts of our research laboratories in one word, the word would be prediction or perhaps forecasting.

That's our job. And in order to do that, we do basic research. We do applied research. What we say is that we do purposeful research. Our research has the purpose of providing better capabilities to those services so as to provide a saving of life and property and to providing economic cooperation in industry, particularly such things as the transport industry and so forth.

For many years now we have been developing various kinds of instruments that are used in pursuing these ends. The next radar systems that many of you have heard about were developed in our laboratory. The Doppler capabilities were developed in our laboratories. Our Severe Storms Laboratory in Norman, Oklahoma and our Wave Propagation Laboratory here in Boulder.

Those are now approximately somewhere between—we're not sure exactly how it's going to end up—but somewhere between $750 million to $1 billion in procurement, depending on which aspects of it you count, and that contract went to UNISYS.

We also have another contract with UNISYS, for example, in procurement of profilers. The profilers have been made by a number of different companies. There are a number of small businesses that are involved in it.

So there are many different kinds of activities that we are involved with and we welcome the cooperation and working with industry.

We have a number of small business connections at this point. One of the things that striking about them is that none of them are in Colorado. I can list for you, for example, just a few of the ones that we have dealt with. Here's a company in Rome, New York, Dove Electronics. A company in Orlando, Florida. A company in Ohio. A company in Maine.

We have not had the response from the small business area in Colorado that we would like to have and we are open to consider and to work with you to aid you to work with our facilities.

It's been mentioned by each of the preceding speakers that there are a number of facilities that are available through the Government Laboratories and through the university laboratories that you could take advantage of. If you wanted to test certain kinds of instrumentation, for example, NOAA has aircraft and ships in our research activities.

We've had companies, for instance, put instruments on board our hurricane-seeking aircraft, our hurricane measurement aircraft, hurricane reconnaissance aircraft. Those instruments have been tested under severe weather conditions to measure various aspects of the oceans and the atmosphere.

And the companies have been welcomed aboard on a basis of mutual aid. We benefit because of the fact, if their instruments work well, we can then procure them through our normal procurement processes.

So we're very anxious to have industry providing these kinds of instruments. We are not interested in building instruments ourselves, but we have to do it because up until now we have, in many cases, not found the industries who are interested and willing to do this for us.

It is sometimes a very, very long research process that goes on for perhaps 10 to 15 years before you can be assured that a given

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instrument will be available to make the measurements in the ocean, in the atmosphere or in space, for example, that we need to do, and many private companies cannot do this.

I would mention just in passing that I will leave my cards on the poster—one of the poster desks outside. I can be approached, but I'm often out of town. Dr. Bob Trotter, of my staff, is frequently available, but if you simply contact my office, we'll see to it that you understand how we can go about solving some of the problems for us and for you and combining in cooperative research.

Thank you.

[Applause]

Mr. SIEVERS. Our next speaker is Mr. Dana Moran, Director of Research and Technology Applications for the Solar Energy Research Institute.

And I should say that the reason we're marking right through these presentations is because we want to give you a chance to ask hard questions at the end of these formal presentations.

STATEMENT OF DANA MORAN, DIRECTOR, RESEARCH AND TECHNOLOGY APPLICATIONS, SOLAR ENERGY RESEARCH INSTITUTE

Mr. MORAN. Bob, thank you.

If it's okay with you, I'm going to sit here because I have a slide control. Could I ask someone to turn on that slide projector, please.

David, colleagues, old friends and new friends, I feel a little bit like Elizabeth Taylor's fifth husband because everything I ever wanted to do has been done already and probably better.

[Laughter]

I want to start with brief reiteration. You might say repeat for emphasis on some of the things you've heard already.

Let me note that you may be amazed to find that there are 388 Federal Laboratories conducting research and development in this country. $20 billion-worth of R&D is conducted by those laboratories. One-sixth of all the scientists and engineers in this country are in the Federal Laboratories. Half of the R&D funded in this country is conducted by the Federal Government.

And there is on the table in the center of the area displays in the center room—you'll find a list of some 20 of those Federal Laboratories that are here in the Rocky Mountain Region. Three of them are represented with you today: my own organization, SERI and NOAA and the Bureau of Standards.

You'll also find on that same table a listing of a publication announcement of a book published by the National Technical Information Service called "U.S. Government Technologies and Assistance," and I recommend that to you as a publication to acquire because it will provide to you extensive details on the resources and capabilities of these laboratories that you may be able to employ.

The sight is a little dim, but as I said, it's a repeat for emphasis. We just wanted to note the variety of ways in which you are enabled to work with the Federal Laboratories through research collaborations by utilizing the facilities of the laboratories. Most of the facilities of the Federal Laboratories, if unclassified, are avail-

able to you to come in and conduct experiments and perform proprietary research, to conduct studies on your own work.

We welcome, in most of the Federal Laboratories and all of those that are represented here today, visiting researchers, who could spend some time working with their colleagues in the laboratories.

We conduct cost-shared research programs by subcontract or by cost-shared and this benefits both the Federal program and the participating companies.

We are now in a position, as was mentioned earlier, to accept private sector sponsorship of research in the laboratories, under some limitations, but to make available to you for your own proprietary research the capabilities and skills in these laboratories.

And finally, and maybe particularly importantly, the recent legislation that was mentioned before enables the Federal Laboratories to license proprietary or intellectual properties that come from the work in the laboratories.

And a brief word about the Federal Laboratory Consortium, which is the network of some 300 of those Federal Laboratories. In fact, it represents more than 14 Federal agencies and here, briefly, for you is a list of the agencies that are represented through the Consortium.

It is a network. It's an interchange. It's a means of providing contact with any one of those laboratories to obtain more information or to find ways to work together. The easiest way to contact those laboratories is through the Office of Research and Technology Applications. Each laboratory is required to have one.

Bob Trotter represents NOAA, I hold the position at SERI, and Bruce does at the Bureau of Standards. So we'd be a good point to start if you want to contact laboratories out of state as well as in state.

And you will find on that center table in the SERI display a folder which gives you further details on the Federal Laboratory Consortium. I encourage you to pick up a copy.

Now, finally, a bit of a commercial for the Solar Energy Research Institute. We are a Federal laboratory operated for the Department of Energy operated by Midwest Research Institute.

That energy we receive from the sun can be converted to the useful forms of energy that we employ in our society through a variety of solar conversion technologies and these, in effect, represent the scope of work at SERI. You'll see, in fact, that our research programs encompass photovoltaics, wind energy conversion, biotechnology, bio-mass conversion, bio-fuels, solar thermal energy, the use of solar energy in buildings and energy management in buildings, the energy available from the ocean from the temperature differences in the ocean, as well as the assessment of the resource that's provided to us by the sun.

And you will find in our exhibits out here in the Durango Room examples of our work in each of those fields.

So, SERI is located in Denver West Office Park. We occupy three buildings. Our headquarters are there. We have our permanent facilities in the South Side or South Table Mountain. I'm sure you've all drive out I-70 and seen to the right that building with the red stripe on it and the black roof? That's SERI's principal biotechnol-

ogy research laboratories, and just to the west you'll find our field test facilities.

A brief summary on SERI. We have about 430 full-time researcher and technical staff and about 100 visiting professionals.

And I thank you very much.

[Applause]

Mr. SIEVERS. Our final panelist is Dr. Bob Calcaterra, Director of Research and Development for Adolph Coors Quality Analysis Laboratories. Coors is obviously not a Federal Laboratory, but we've asked Bob to share with us some of his views and experiences, the different forms that technology transfer can take. Certainly he's in a good position to do that as the outgoing Chair of the Colorado Advanced Technology Institute.

Bob.

STATEMENT OF DR. BOB CALCATERRA, DIRECTOR, RESEARCH AND DEVELOPMENT, ADOLPH COORS QUALITY ANALYSIS LABORATORIES

Dr. CALCATERRA. As Bob said, I guess I'm the industrial advocate here today.

I was very surprised when I really started to look at this. I had perceived it a little differently. But when I started to look at my own case and what happens when you get technology transfer from universities or laboratories I found that was a common thread, and you may agree or not agree, but this is my experience.

Basically, what I found was that there has to be a mutual benefit to both organizations, and in general, it's a need of industry that is filled—because of expertise of equipment that exists in the laboratory or the university.

I also found that for these to work very well it took a very close relationship between people in both organizations. In other words, I'm advocating champions in both organizations to get something going. As a result, I advocate—at least I favor some artificial creation of contact between the two organizations. For example, I favor sabbaticals—people going from both organizations into the other.

And those people should be certain types of people: people who are social, who interact with other scientists on a frequent basis, who are the kind of person that walks around and talks to people, likes to talk to people and see what other people are doing. An idea person. A person who is always thinking about how can this be applied. What new can occur.

Also, I advocate continuous relationships, such as laboratory membership at universities or national labs and a minimum regular meetings between the two organizations. Of course that's the approach we use in CATI.

There is one problem that occurs and it's something that CATI is trying to address right now, is that—of course small start up companies do not have the wherewithal to join organizations, and besides that, they don't have the time.

I have a large staff. I can appoint people to attend meetings and participate in laboratory discussions in membership. Where, if

you're starting up a company your main need is to get on with the job and you don't have the time.

So we're trying to address in CATI—I don't see the solution, but something needs to be done to allow that to happen because certainly large industry is not the only way we're going to build this type of thing.

For example, just within my own organization, Coors, we have relationships with Georgia Tech, Oregon State, Colorado State, CU, Colorado School of Mines and even DU. And I looked at everyone of those relationships within my organization and the interesting thing that I found —we also have a relationship with Vanderbilt.

With the exception of Vanderbilt, every time we had extensive long-term discussions and had built a relationship nothing happened for quite some time. Then, all of a sudden, somebody perceived a need and because of the relationship that was built before that happened, that is when everything triggered and we built the project or the program that now exists.

That in fact happened with SERI and the National Lab. Also in a relationship that we're now building with SERI we had enumerable meetings between my scientists and their scientists where we understood the capabilities of each organization and Coors recognized a need and that allowed us to proceed.

And in every one of these cases, also, it was a need of industry and the expertise or the equipment that existed in the laboratory of the university.

Thank you very much.

[Applause]

Mr. SIEVERS. I'd like to open this up for discussion and questions, so let's see whether you have any questions. It's always hard to get the first question.

Yes, sir.

Mr. SOCASH. What I've heard is the transfer coming from the Government labs to private industry, and I think the point is well taken, that the small companies have no resources to take advantage of this.

Is there anything going on with regards to an influx of technology from small companies where you're looking for something to have a very specific subcontracting mechanism? It's very difficult to even find out what's going on and then to get a proper hearing.

Mr. SIEVERS. The question was, in most of what has been said so far we're talking about knowledge generated in the Federal Laboratories and how one gains access to that. What about the reverse sort of process in which ideas are generated by small companies to satisfy needs that may exist either within the Federal Laboratories or in the community and at large and how can we stimulate that? Is that the essence of your question? Who'd like to take a stab?

Dr. CALCATERRA. I didn't address that in my discussion, but we, in fact, have had innumerable contacts with very small companies. In fact, a lot of SBIR companies have approached us, basically through the process that the Federal Government has set up.

We haven't hit on anything yet, but by no means do I see that this is only tied to federal labs and universities. It certainly does include small companies. It's just that I can't cite any relationship that we have at this time.

Mr. SIEVERS. Okay. Other questions.

Yes, back there. Would you state your name, please, and your affiliation.

Mr. LOCKWOOD. Lockwood, Cybernetics. Woodstock, Colorado. I am a graduate of the National Bureau of Standards and upon leaving the National Bureau of Standards, I started a small company and then later needed to facilitate the organization. One problem that I ran into at that point in time was that because of the internal organization, I needed some special calibration processes and that was going to cost my small company a number of dollars which at the time was fairly large for the size of the company.

Has the technology transfer process moved to the point that small companies, who are very limited in their resources, can take advantage of the internal technology? I knew where a lot of the technology was in the organization, but at that time I simply couldn't take advantage of it. Because of the internal structure they couldn't exchange resources unless they were partners.

What's the status on that.

Mr. SIEVERS. Excellent question. Bruce, would you like to address that.

Mr. MATTSON. I don't know when you left the Bureau, but I would say that there is increased flexibility in terms of small business access to technologies, particularly through the collaborative research agreement and arrangements, where you can contribute some of your firm's resources and the Bureau would—if it's part of its particular mission and if it's a technology, it probably is—would contribute or devote some of its resources to developing that technology.

So, that exists. I think that's an improvement in terms of what has been.

I know that in addition to that there are states that are considering leveraging their small business access to Federal Laboratories and I don't know whether that's true in Colorado or not, but there are states that are considering that and it's also an additional leverage mechanism that you can have.

I would say that it has improved. Now, I guess I don't know what particular point in time that you—

Mr. LOCKWOOD. About ten years ago.

Mr. MATTSON. Okay, I see. It's probably changed substantially since—over the ten years.

Mr. SIEVERS. Do the states actually have set-aside funds that they are prepared to indirectly invest in the small businesses?

Mr. MATTSON. Right now, states have set aside funds they use in collaborative research projects with the universities, and I think they found that that's a fairly successful approach. And the states that have the Federal Laboratory resources, naturally can use the same kind of an approach.

Mr. SIEVERS. Well, clearly, the problem arises, it seems to me, in that public entities, like states, would have difficulty indirectly channeling funds to a particular company to foster a particular survey or a particular development need for that company.

But it also seems possible that if there is a generic set of capabilities that would be available to all comers or if there is research needed to bring a fundamental idea far enough along so the compa-

nies can take it over, that that would be within the realm of what the public sector could legitimately support—whether it's at the state or at the federal level.

Mr. SIEVERS. Any comments on that?

Vernon, first. Okay.

Dr. DERR. I guess my microphone isn't working so I'll just speak loudly. Sorry for the harsh voice.

The Small Business Innovative Research Act does take away from each of my laboratory directors a certain percentage of external research funds each year. They're very anxious to get that back, and the way they get it back is by entering into an arrangement with a small business. And we have, I mentioned, something like six to eight of those in operation at this time.

So, some funds are available. They're not available as a cash payment to the people—to the small businesses outside the Government. It's specifically forbidden for us to provide cash. But through this Small Business Innovative Research Act, SBIR, we can provide capabilities that we wouldn't otherwise be able to.

Mr. SIEVERS. Dana.

Mr. MORAN. Just one other comment on behalf of the Department of Energy Laboratory.

The DOE policy regarding access to the facilities or laboratories is fairly generous. What it says is that if the work that the visitor or the user wishes to do is not proprietary, is directly related to the mission of the laboratory and if the data that result from those studies or tests are available to the laboratory for publication, then we can make the facilities available without charge.

If the work is to be proprietary and the data is to be retained as proprietary information, then we must charge what's called full-cost recovery. That is, we must charge all direct costs.

For small businesses, I would note, and don't quote me on this, but I would note that we've made a considerable effort to ameliorate some of those costs when small businesses are involved. I think that would continue to be our policy.

Mr. SIEVERS. Bob.

Dr. CALCATERRA. I have to say something about CATI based on what you said about the state's responsibility in this thing. CATI feels very strongly, as you said, that the state's responsibility will be—or should be to in fact take ideas and show the commercial value and be responsible for that piece and be able to help small companies in that area.

We haven't established quite how we will do it, but we do in fact feel that that is the state's—the direction the state should go.

Mr. SIEVERS. More questions?

Yes, sir. State your name and affiliation, please.

Mr. HALLECK. My name is Mike Halleck, from HWI Manufacturing. We develop commercial products for other companies.

We have needs periodically for equipment that is high cost that we possibly can't afford and it was stated that NBS may have equipments available to fulfill purposes for small businesses.

Could I expect to be leasing or renting that equipment at less than what I could get on the commercial market? I heard that perhaps the Government likes to recover their costs.

Mr. SIEVERS. I'm going to ask—

Mr. HALLECK. Also, the Government costs sometimes get to be very exorbitant and not competitive at all with the commercial market place.

Mr. SIEVERS. Bob, are you willing to address that?

Yes, please come up here.

Dr. Kamper is Director of the National Bureau of Standards Boulder Laboratory.

Dr. KAMPER. Don't mistake us. The facilities that Bruce is talking about are rather elaborate laboratories. They're complete labs that were set up for special purposes, costing millions of dollars. This kind of thing.

The arrangement we invite you to join us with is to come and do research. Something—a topic of mutual interest, in which case, we both contribute to the research and take away the benefits of it.

We are not an equipment rental organization. We do not rent equipment out. It is strictly forbidden to compete with private companies who would do that.

Mr. HALLECK. I was thinking of something like and electromicroscope, which a small business couldn't afford. Is it possible to have access—

Dr. KAMPER. If you have an interesting problem and talk the person who has it, then they quite likely could make arrangements to use it now and again. But that would have to be an individual arrangement.

Mr. SIEVERS. Yes, sir. Your name and affiliation.

Mr. RAPP. Bill Rapp with Confertech International.

Mr. SIEVERS. Would you come forward, please. We're recording this for posterity, so why don't you get—

Mr. RAPP. I'm Bill Rapp. I'm with Confertech International, which is short for Conferencing Technology.

And I'm particularly interested in the collaborative research and what I'd like to know is from the day that we decide that there's something available to us at one of the labs and we make that initial contact and there is a good fit, are we talking about one month, two months, three months, a year before we actually get into a research project?

Mr. MATTSON. Given that there's a good fit and that it follows all of the requirements of the division and the laboratories and so forth, it can proceed very quickly and could be processed as quickly as four weeks or less. It's very quick, at least within NBS.

Mr. SIEVERS. How about for the other organizations?

Mr. MATTSON. I would say for the Department of Energy and the Department of Energy Laboratories it could be any one of the above because it will depend entirely on the situation.

Some are readily licensable, are ready to be transferred. Others may take months because of the complexity of the arrangement.

Mr. SIEVERS. Any other comments?

Dr. DERR. It depends on the complexity of the project. In the case of a simple project, we have ones that we put through in a month or two months. In some cases it's taken a couple of years because of the research aspects and the difficulties of the sciences to arrive at an understanding at what a correct procedure is.

So it varies widely as to whether—what the time is, but if it fits all the requirements, it can be done very quickly.

Mr. RAPP. Well, the fields we are in move so fast in communications—and you're driven by your users, so oftentimes you need to be involved in what your shortest time- span was, a month or so, in order to be any good to them.

Thank you.

Mr. SIEVERS. Thank you.

Other questions?

Yes, sir. Name and affiliation.

Mr. WIDMARK. Albert F. Widmark, Custom Biologicals.

I'm interested in the question, technical question of conflict of interest. For example, I work with biological research people and university and other places and—for example, a professor, a research professor might also be a stockholder of a company that is doing research in the same area of research that he is also doing at the university. And these people have a problem of conflict of interest.

Would someone like to speak to that question?

Mr. SIEVERS. The gentleman is worried about potential conflicts of interest and, as I listened to his question, I'm reminded of countless faculty meetings that I've sat through where the subject has been discussed.

[Laughter]

Mr. SIEVERS. Let me first offer some additional thoughts because I think that the conflict of interest matter is always a very real and substantial one. It's one that people will worry about perhaps to the point that they are immobilized.

It's one that causes all kinds of excuses to be given why we can't cooperate with so and so or we can't allow this to happen or we shouldn't do this because the student might be abused or that the thesis work might be delayed for six months while the company that is sponsoring their research tries to get a patent on it.

In my experience and from my judgment, there have been very few instances of flagrant abuses of the potential conflict of interest problem. But this, I admit, is so open to a person's personal views and perspective that I don't think we'll ever get an agreement in any of our organizations—Federal Labs, government universities, even private companies have conflict of interest problems. That there's any way we can really address that substantively in the two minutes that remain in the panel.

Any other panel members like to—

[Laughter]

Mr. SIEVERS. —touch that?

All right. I think the time has come when we need to take a ten minute break, but let me thank you for your participation in this, and I turn this back over to David.

[Applause]

Mr. SKAGGS. Thank you.

Thank you, Bob, and thank you very much to our first panel.

Our break refreshments are being brought to us courtesy of the Adams County Economic Development Corporation and we thank them.

I just want to emphasize that what you have seen in this first panel is representative, but far from exhaustive, of what's available within the Federal Government. As one of the charts I think Dana put up showed, virtually every department of the Federal Govern-

ment has a research activity of some sort or other going on. Anything from the FBI labs to the Agriculture Department. You name it.

We particularly tapped those that were here locally, but those should not be seen as the end of the message by any means.

Thank you again. We've got to stay on schedule, so please grab a cup of coffee, come back to your seat and we'll get started in about seven or eight minutes.

[Recess]

Mr. KEEVER. Okay, Congressman Skaggs.

Mr. SKAGGS. Thank you, Jack.

I wish I had all the resources, but you are kind to suggest that. I know it's always absolutely like pulling teeth to settle back in after the mid-morning break, but we are determined to stick to schedule.

We now have a microphone up front here, so when we get the questions at the end of this next panel, please come down the center aisle and take advantage of that. We're making a transcript for the benefit of my Committee in Congress of the proceedings today. So we would not want your questions and comments to be lost.

Our next panel will focus on what is available within the university community in this part of Colorado, much along the same lines as what is available in Federally-funded laboratories.

This panel is moderated by David Hirsh, who along with Bob Sievers, has been particularly helpful to me and Cary and Jack Keever in putting this entire day's activities together, and again, my thanks to David for his help.

He is Executive Vice President and Director of Research for Synergen, Incorporated, which he co-founded with another alumni professor from the University of Colorado's Department of Molecular, Cellular and Developmental Biology and is himself, I guess, a living breathing example of technology transfer from university labs into private business.

He remains an adjunct professor at the University of Colorado. A member of the American Association for the Advancement of Science. And his own particular research interests have been, in those areas that I can pronounce, developmental genetics, nucleic acid structure and function, and, David, thank you very much.

[Applause]

STATEMENT OF DAVID HIRSH, EXECUTIVE VICE PRESIDENT AND DIRECTOR OF RESEARCH, SYNERGEN, INC

Mr. HIRSH. First I want to thank David Skaggs for bringing this experiment to the bench. This being our new bench in which to do it.

And I would also like to remind him and you that it is in the tradition of the Founding Fathers that this is being done. That both Jefferson and Franklin, of course, had profound interests in intellectuality and science—

[Laughter]

Mr. HIRSH. —and he is carrying on that great tradition.

But more importantly, vis-a-vis the session we're about to enjoy and, to some degree, the session we just heard, those men made it a

point to include the patent issue in the Constitution, and—because they understood very clearly the need to protect information, ownership, proprietaryship and also to make it available to the public for use. And that was their purpose for putting that in the Constitution.

And it is in that tradition, I think, that this kind of technology transfer is met.

Our session now changes a little bit in its tone because we're not dealing with Federal Laboratories whose stated mission is not only to carry out research but to transfer that research to the public, but to now address the transfer of technology from the university and the college in the State of Colorado to you, the business community.

As David mentioned, I certainly, myself, have made that transition back and forth, having been a professor at the University. So I, to some degree, understand some of the difficulties in extracting from the university that kind of cooperation that is needed by the private community. And it's not easy. There are prices to be paid by both sides, and perhaps these are some of the issues the speakers will address.

But more importantly, I would urge the members of the panel to tell you directly how you can access the university and the college in this State to help solve problems. And I think that's the main thing, that these institutions of higher learning have, as their primary mission, the generation of new ideas in the solving of problems.

And it is certainly your experience and mine that we have problems in the private sector that need to be solved. The question is how to do that in a sharing way.

Without any further comments, I will start with Colorado State University making a comment, as represented by Dr. James Brown, who is the Assistant Vice President for Research, and serves as the University Patent Officer.

STATEMENT OF DR. JAMES BROWN, ASSISTANT VICE PRESIDENT FOR RESEARCH AND UNIVERSITY PATENT OFFICER, COLORADO STATE UNIVERITY

Dr. BROWN. I'd like to thank Congressman Skaggs. We are outside the boundaries of his District and we really appreciate the opportunity to be present at this conference today.

As you are aware, Colorado State University is the land grant university in the State, and as such, we have a very wide array and very diverse amount of research and educational activities taking place on campus. And as such, we think that we have a great deal to offer to the businesses of the State of Colorado.

Now, the one thing that we would like to stress, and I think somewhat the exemplary in our display that we have at the back of the room is that we feel that technology transfer and research is truly people-to-people. Sure we have laboratories. We have facilities. But people-to-people is the important thing that we need to get across, I think, in any of our discussions today.

And along those lines, we would encourage you to visit our campus, to contact me, to contact others who will be here today,

and come and see what we have available, and hopefully, we can have some very interesting interaction.

Now, we have opportunities for students to work with you during the summer months. We have opportunities for faculty members. As Dr. Calcaterra said earlier, we have sabbatical arrangements. We have many programs such as that in place at the present time.

A question came up earlier about the use of equipment and using facilities. Universities do have equipment and facilities available for the private enterprise, but you pay for the use of that equipment and those facilities. And we will charge you the same as we will charge any other users, but they can be made available. Electromicroscopes, for example, or other such facilities.

We, in dealing with industry, find that each interaction that we undertake is unique. It has its own unique set of circumstances. It goes the gamut of exclusive relationships to non-exclusive relationships, and we understand that in dealing with private enterprise because it is a difficult situation.

You're out there to make money and to make a profit. We're here to educate and conduct research as a non-profit organization. How do we have a marriage take place between such two diverse organizations?

And we do and are able to do that and most of them we find to be very beneficial, and also, the people we've worked with felt the same way.

One of the things that you need to be aware of is that the University, in conjunction with our research foundation and private enterprise in town, has developed a research park which is right adjacent to the campus. We do have tenants already. Some small business people have moved in.

This will afford excellent opportunities for the campus community to interact with the private enterprise and help serve their needs. And we're really excited about what's taking place in this arena.

Many of the things that we can do, we recently undertook some computer-assisted design work with a local manufacturer who was having problems with their manufacturing process. We were able to do some computer modeling for them and solved the problem in a very short period of time.

We also have activities going on in our wind tunnels, environmental wind tunnels. We can do environmental studies, building designs, and so on. We, again, have feed trails, feeding supplements for animals, for cattle. We have our biological science programs. Our clinical science programs. Our college of veterinary medicine. The college of forestry and natural resources.

So many areas that we feel that we have opportunities to interact with you people here today.

Again, I urge you to come to Fort Collins. We are there. We want to help you people, and hopefully, between the two of us, we can create more jobs for the citizens of the State.

Thank you.

[Applause]

Mr. HIRSH. Thank you, Jim.

Let me give you an example of the truth that he speaks.

At Synergen we have recently developed a product which stimulates blood vessel formation and aids in wound healing. The question became, will it work on bone fractures?

We don't have animal models of bone fractures. At SCU Veterinary School, Dr. Winthrop has a very extensive program there in studying wound healing and bone fractures, and very quickly, within weeks, we were able to team up with Winthrop and carry out right now rather extensive animal research on whether this compound will accelerate fracture healing.

Our next speaker is from bones of another kind, namely those from the land.

[Laughter]

Mr. HIRSH. This is John Cordes, who is currently the Dean of Graduate Studies at the Colorado School of Mines. John was formerly the head of the Mineral Economics Department, and I welcome him to tell you about their opportunities.

STATEMENT OF JOHN CORDES, DEAN OF GRADUATE STUDIES, COLORADO SCHOOL OF MINES

Mr. CORDES. Thank you David.

Ladies and gentlemen, those of us in this room represent groups which will play a very influential role in the future advancement of Colorado. All of us inherently recognize the mutual benefits and advantages possible by close and constructive cooperation between universities, Federal Labs and the private sector, yet in many of our experiences we have found that the mechanisms for this kind of interaction are extremely difficult to access and to facilitate.

For that reason, I want to join everyone else in thanking Congressman Skaggs for making available to us this forum, this opportunity to both promote and to strengthen the kinds of linkages so necessary for common success.

I represent a very unique institution in the State of Colorado, the Colorado School of Mines. Mines is designated by statute to have a fairly special primary mission as an institution of higher education devoted principally to the area of energy, minerals and materials engineering and science.

As a modern university in science, engineering and high technology, the scope and diversity of our educational and research activities are often not so widely recognized. Indeed, this morning when I first met David he indicated to me that he didn't think he had much in common with geology and mining.

In fact, the Colorado School of Mines is a much more different kind of institutions, and I want to tell you briefly about the school of mines. And in fact, it may surprise many of who are not familiar with today's CSM to know that our major corporate sponsors increasingly are coming from outside traditional resource companies.

Indeed, four of the five largest corporate research sponsors at the Colorado School of Mines are represented by groups like IBM, Texas Instrument, Gould Computers, et cetera.

Similar kinds of trends exist in the placement of our graduating students.

In short, I want to emphasize that while at CSM our roots remain strong in the traditional resource and materials industry,

the products of our education and our research creativity are being increasingly applied to a large array of science and engineering areas, such as robotics, advance materials, superconductivity, expert systems, artificial intelligence, waste management, et cetera.

...in addition to those traditional areas of exploration, extraction and the processing of ores and hydrocarbons.

Research activity at the School of Mines is largely oriented in seven major thrust areas which are specifically defined by 40 individual research centers or institutions. David Olson. who is our Dean of Research Development, is in charge of coordinating CSM's overall research activities.

In fact, I am here today because David is practicing a particular type of academic technology transfer. He is in Vienna giving several papers in an international conference on welding and joining advances in technology.

In order to capture some of the dynamics that exist at the CSM Research Laboratory, we have prepared a directory of our centers and institutes, which is available at the poster display area for this afternoon's sessions. In it you will find brief descriptions of the 40-some centers and institutes that we have, including names and telephone numbers of the particular directors.

Representatives from several of the centers will also be available at that time.

As has been emphasized by Jim already, universities operate slightly differently than the Federal labs, particularly in the sense that our principal motivation is the education of future leaders in industry. At the same time, to make that education effective, we are actively involved in the forefronts of technological development.

We have ongoing facilities which serve dual purposes. The education of young men and women, as well as the production of new technologies and ultimate steps toward their commercialization.

For individual companies to access them there are a number of various mechanisms which run in the continuum from joining ongoing research projects which have a consortium of corporate affiliates to the very specific kinds of problem orientation which is intended to solve a particular type of research, question or issue.

The question of confidentiality, conflict of interest, proprietary knowledge, as was indicated earlier, is a serious problem. We at Mines, and I suspect at the other institutions represented here, have developed particular kinds of proprietary information and confidentiality rules which provide useful delays which can make commercializable or patented technology to become available to the general public after a reasonably useful delay in terms of publication of student thesis, as well as the general faculty researched publications themselves.

In specific, CSM has to offer ideas for new research, participation and a whole range of ongoing research areas, as well as a shelf of patented or patentable products for commercialization.

To give you a brief indication of some of those—the patentable or patented products that we currently have available include new welding consumables, high temperature adhesives, advanced ce-

ramics materials, specialty coding techniques for materials, et cetera.

In my remaining minute or two, I would like to mention two types of perhaps unusual technology transfer that are currently going on at the Colorado School of Mines. One of them we just started this current week, which is perhaps slightly outside the scope of this conference, but it represents a unique kind of partnership that can exist between the State, the Colorado School of Mines, and private industry.

It's a situation—we have a private project in hazardous waste management where the State of Colorado provided the resources, the financial resources. The School of Mines provided the technical expertise and a group of five corporate interests in the Denver area provided the jobs.

Through that particular kind of program we currently have 15 un- or under-employed civil engineers and our scientists, who are going through an intensive 12-week applied program. At the end of that period of time all the companies have guaranteed them job offers in the $50,000 a year kind of range.

I emphasize that particularly because we are in the business of training.

The other kind of technology transfer activity that's going on comes out of our Center for Welding and Joining Research that I want to indicate, and that is a series of expert system applications to welding which are now commercially available to facilitate various types of welding processes.

Thank you.

[Applause]

Mr. HIRSH. Thank you.

One of the real pleasures I've had in being part of the organization of this meeting, is meeting Cary Israel, who is our next speaker and is President of the Front Range Community College.

STATEMENT OF CARY ISRAEL, PRESIDENT, FRONT RANGE COMMUNITY COLLEGE

Mr. ISRAEL. Thank you, David.

It's been my pleasure—it's been a success for me already this conference for the ability to network with all the different people and to work with Congressman Skaggs and his leadership in getting this together today.

We're not in the Big Eight. We don't have a football team.

[Laughter]

We don't do research.

What we're really doing is we work where the goats can eat the hay. That's what we're doing.

[Laughter]

We are really working with this technology and we're not vendor specific. We're using all different types of hardware and software and we're begging the private sector to work with us, and to take advantage of what you pay for.

We do have one of the largest solar paneled buildings in the world, and it was the largest until recently someone told me in Saudi Arabia they built a larger structure than what we have.

I'd like to talk a little bit about our programs and what we're doing. And hopefully, you know, the idea was to bring your cards to network and I forgot mine.

[Laughter]

I practiced law for 15 years before coming to the Community College and I used to put velcro on my cards. So I hope some of you have velcro on your cards to throw at people, too.

We have, at our institution, wonderful CAD and CAM facilities. We are at a state, at this particular time, that we're experimenting and creating the first, to our knowledge, CIMCELL, a computer integrated manufacturing cell, at the institution to work with private industry, business and Government. I call that big.

A year and a half ago we were successful, and a lot of people don't know. We landed a Ford Motor Company Asset Program, one of six in the United States. Because the technology had exceeded the competencies of the people who were quote "the mechanics" we don't call mechanics any longer. We call them technicians.

And what we have now is all the brand new cars. They won't give me the keys to the Lincoln Continental, yet. We have all the new cars and a $150,000-worth of new software because you have to understand physics, you have to understand electronics and you have to be sophisticated, no longer a grease monkey.

We had 365 applications for 26 slots. This is marriage between business and the community college. We chose 26 people. Every person had attended college, or had a degree. We have two people that have masters degree in the program.

They spent ten weeks at the college. Ten weeks in a dealership in the Eight State Rocky Mountain Region. Ten weeks with us and it goes on for two years. So at the end they will be certified working for Ford Motor Company.

We have a dietetics technology program. We just won a League of Innovation Award from IBM for a menu planner. Libby Piner, a professor, did that. She just turned 70 years old.

We have tremendous capacity of people. Why I say that is because the people are really innovating at our institution. A lot of them are in the category from 55 to 70, and we sometimes have a throw-away society. Well, we're not throwing them away at the Community College.

Hazardous Waste Technology. We were pleased to announce in February the first associate degree in the United States in hazardous waste training. We had 450 applications for that program, many of them with BA degrees and so forth.

In fact, our institution is not small. We have just merged Larimer Tech Center. It's part of ours now, Front Range in Fort Collins.

We have 11,000 students. Twenty percent already have degrees. The average age is 30. Sixty percent are female. Seventy-six percent are working. So we are trying to be flexible and accommodating.

We have one of only ten programs in the United States on desktop publishing and there will be demonstration on the CAD, the CAM and the desk-top publishing here.

We have one of the finest nursing programs in the United States. We had a student last year that wrote a perfect exam nationally on the RN.

And on and on.

We have been aggressive the last year to really work with business and industry, and we have a contract, a training- customized training facility to work with them and have worked with over 100 companies in helping them solve problems.

For the businesses that are expanding out there, we can tap into funds for training through Colorado First. So there are funds available for your training.

We had received a national award for our Jerico training and expansion here in Thornton of 100 jobs because of producing Snuggly Products and the geri Baby Products.

We have created a small business development center—there are 15 in the State—through the Colorado Community College System. We had one housed at Front Range, one housed in Fort Collins. But we have a twist in ours here in Westminster. We have an international small business development center and are active with Adams County and Jack Keever, whose fine leadership in this community has helped integrate the Community College with that community.

So, use us. Come and talk to us. We need your help. We are conducting asbestos training, OCEA training projects. We are hiring private sector people because we do not have the capacity to do everything.

We want to hold hands with the university because we believe that we are a logical part, not the research part, the Big Eight, or so forth.

Thank you.

[Applause]

Mr. HIRSH. Thank you, Cary.

The next speaker is my neighbor and the institution with whom we have considerable contact and ongoing programs, Don Hearth from the University of Colorado at Boulder. He's Associate Vice President for Research.

STATEMENT OF DONALD HEARTH, ASSOCIATE VICE PRESIDENT FOR RESEARCH, UNIVERSITY OF COLORADO AT BOULDER

Mr. HEARTH. I have one comment for Dr. Israel. You ought to be glad you don't have a football team.

[Laughter/Applause]

We have a few football players we might want to trade with you.

[Laughter]

One of my favorite definitions of the term innovation is that innovation equals idea, plus exploitation, and the reason I mention that is because it illustrates, to my mind at least, the importance of this kind of a conference and the importance of technology transfer because a provider of an idea, whether it be a national laboratory or a university, is really not in the position to exploit it. And to have that linkage of idea and exploitation occur, then the private sector must be intimately involved and technology transfer is required.

From my background in management and private industry and national laboratories and now a university, part of my job this morning is to point out to you some of the differences that exist between dealing with national laboratories and dealing with uni-

versities, and I'll try to do that in these remarks because it is, indeed, different.

In addition to having a football team, the University of Colorado does have a very large research program. And I want to draw your attention to two documents that we brought along this morning. This one is called the "Research Report," which came out earlier this year which is kind of a glossy thing that summarizes the $120 million to $130 million a year of research done on our four campuses.

The other document, which is a first printing, came out yesterday—and I have to apologize in a moment for the cover—is a more in-depth discussion of about 15 or 16 areas of research going on on our four campuses that we get a lot of inquiries about from industry and there are phone numbers and names and contact points in both of these because, as others have pointed out, this is indeed a contact sport in which you have to have one-on-one interface.

The apology I want to make on this is on the cover and this is a university-wide document and not a Boulder Campus document, but if you look at the cover you can tell which campus printed it—

[Laughter]

—because it says, University of Colorado at Boulder. So I apologize to my friends from the other campuses who may be here.

As I mentioned, the research program at the University is a large one and, therefore, it's extremely comprehensive and that, in a way, is both a plus and a minus for somebody who wants to tap into it. It's a minus because it means that you have such a wide array of individuals to tap into. Because, indeed, in a university it's a very bottoms-up kind of an organization. It's not like even National Labs, and particularly, it's not like a company. It tends to be a little bit more top down.

You really have to get into individual faculty, individual departments, individual research groups.

Let me make another point. Our University, and that's true, I think, of my colleagues on the panel, we own the intellectual property that results from the research at the University. That research—the intellectual property, patent rights and so on, is not owned by individual faculty members. Generally it's not owned by the sponsor, and I'll come back to that in a moment.

We have a very aggressive license, a patent and copyright policy. We license rights all the time to industry and, in fact, we make, frankly, quite a bit of money from that activity; on the order of $1 million a year.

The University participates in new ventures with equity positions, and the like, in which intellectual property from the University is being exploited—going back to the definition of innovation—is being exploited by some venture capitalists and private entrepreneurs, as well as the University as a partner.

We encourage industry sponsorship. About $130 million a year or so in funded research. Most of that is from the Federal Government, but a growing segment of that is from industry. And we encourage that.

Now, we recognize that by sponsoring research at the University, industry has threatened rights and interests in the intellectual property and in the publication or the non- publication of results. And as pointed out on page 43 of this document, we have a policy

which permits us to negotiate publication and intellectual property rights and breaks on royalties, on licenses and so on with our industrial sponsors on a case-by-case basis. And the results of those cover the full spectrum, as you can perhaps imagine.

It is important to recognize that that's the way we operate as far as the intellectual property ownership.

A big difference in dealing with the University—at least our University in contract to a National Laboratory is that there's no free lunch in dealing with us, very frankly. And by that I mean that while we publish our research results very openly, in fact, that's one of the drivers in a university, really the technology and the technical smarts are in individual faculty members or individual research groups.

And if you come to a faculty members and say, I need your help, or I have this question, some faculty members will say, fine. They'll sit down with you and will donate their time or they'll do it for a fee. But in a large number of cases that's not the way it works and in an—and so you have to have, as was pointed out before by one of the earlier speakers on the earlier panel, a mutual interest, a mutual benefit viewed from both sides of that table.

And that can take quid pro quo, if you will. It can take very, very many forms.

A number of our activities, and in fact, some of the centers that are involved in the poster displays that you'll see this afternoon, have built into their charter working with industry and provide, quote, "free service," in which the sponsor, for example, CATI or a Federal agency, makes that part of the operation of that research unit.

But there are other mechanisms that I would point out to you in terms of dealing with individual faculty members, which I think is the most difficult and yet it's probably the most—in the final analysis, the most beneficial.

You'd be amazed at what supporting one of his graduate students would do for you in terms of opening the door, and it doesn't cost a great deal of money. And any of you who have ever been graduate students know that there's not a lot of support there, but they're always looking for finding a few dollars to support graduate students and you can do an awful lot with that.

Obviously, cooperative research programs is another way. Our faculty consults, so you can always hire a faculty member as a consultant. Many of our departments, particularly in the engineering school—I'll be through in a minute, David—

[Laughter]

—have industrial affiliate programs, in which a company puts in some dollars each year and that really gives them total access into that department.

I also want to draw your attention to one of our poster displays, and that's the Colorado Business Advancement Centers, plural, which is in one of the back rooms. Their purpose is indeed to assist industry and they are funded by a variety of agencies, including the State of Colorado.

Part of their task is to acknowledge a transfer, and they have access into all kinds of national data bases, federal labs, technology and so on. I would urge you to go by their display, as well as, of

course, all of the others from the University, but particularly that one.

I was going to go on, but obviously I'm late. So thank you very much, and, David, it's been a terrific experiment.

[Applause]

Mr. HIRSH. Thank you, Donald.

The last speaker on this panel is the Vice Chancellor for Research and Technology at a private university, the University of Denver, Dr. Jerry Plunkett.

STATEMENT OF JERRY PLUNKETT, VICE CHANCELLOR FOR RESEARCH AND TECHNOLOGY, UNIVERSITY OF DENVER

Mr. PLUNKETT. Thank you very much.

We at the University of Denver don't feel we understand the private sector. We are private sector.

[Laughter]

That's the first point I'd like to make.

The second point is that most of the other speakers have said a good many of the things I'd hoped to say and they've also taken up my time.

[Laughter]

So, I'll be very brief.

The University of Denver is engaged in research development. We're sort of like the Marines. We're the smaller of the universities in the State. However, we do have an active research program and we're engaged in many areas. We do recognize proprietary research activities. Also classified research. We're the only university in the State which has a publicly declared policy of giving proprietary information directly to our sponsors. If any company comes to us, we don't mickey mouse around about it. You get the patents. So you need to understand that right up front.

We also do classified work. Most universities will not do that. The reason we do that is, we believe it's very much in the national interest.

In 1963, when President Kennedy signed the Atmospheric Test Ban Treaty the University of Denver had developed and put into place the verification system that made that treaty possible, and I don't think there's a person in this room that knows that.

But not all classified research deals with weapons, but it can deal with materials that are very important to the national interest, and we recognize that and deal with it.

The other thing with technology transfer, we're delighted to see that it's progressed so far. The University of Denver made the first study ever done in the history of the United States on technology transfer for NASA. In 1962 President Johnson—I'm sorry, 1963 Vice President Johnson was going around the country. He—you remember President Kennedy had appointed him to sort of oversee NASA to give the Vice President something to do.

He was going around the country declaring all these products that are flown out come from the space program. Unfortunately, we found out that was not true, and in saying so we got ourselves in a lot of trouble, but nonetheless, we said it. It was interesting

that the report was announced on Labor Day in 1963 because it didn't confirm what everybody was saying.

But technology transfer has become an honest activity and a good activity and one that we support, though we're not active in it now.

Also, I would tell you, as small business people, the University of Denver has representatives. We were the only university in the United States who participated in the formation of the SBI Program and testified before the Congress for that program.

The American Association of Universities opposed it, and so, you can see that our heart is with you and we're willing to work with you.

We're looking for a few good people, and frankly, we would like to deal with a few small businessmen, as we have already, in joint ventures. We have a limited amount of money, but we'll place it on certain bets.

If you do want to talk to any professors at the University of Denver, we're certainly willing to do that. however, I caution you that unless you are aware of the last two or three papers which they published, you're probably not going to get a very good reception.

These people are judged on the basis of the papers they publish and if you're interested in an area that's very directly related with what they're doing, you may get their interest.

If you're a small business person and do know somebody in the field and are aware of their papers, if you call them up then you have something to discuss with them and I suspect you'll get a good response. Otherwise, they have their own lives to carry out and conduct and I don't want you to leave this meeting with the misapprehension that these professors are sitting around waiting to serve you. Far from the truth. That's simply not the case. And I don't know of any university in which that's really true.

They have to perceive some advantage for themselves in it.

So, having said all of that, I will give you my telephone number and I'll certainly be willing to act as an intermediary. We have been approached by—over the last four years by about 20 firms, small firms. We have selected two of those. They're moving along very privately and very confidentially with some very interesting new technology developments, and we'd like to talk to a few more people and select a few more firms.

We don't have a lot of publicity about our program—but nonetheless, it does exist. And if you want to reach me, my telephone number is 871-2626. Thank you.

[Applause]

Mr. HIRSH. Thank you, Jerry.

I would also add, not only know their recent papers, but in contrast to the costume that you see here, take off your necktie. It's the easiest route to the academic researcher.

[Laughter]

I'd like to thank the panel for their comments and open this session to a few questions that you may have.

[Pause]

I see, you know that lunch is out there.

[Laughter]

Bob, you want to—

Mr. SIEVERS. This looks like a plant, but it isn't. It's an honest question.

If I as a small businessman want to come to one of your universities and get an exclusive license, as contrasted with a non-exclusive license, because I perceive that it's really necessary to have an exclusive position in order to make development financially attractive, is that now possible with your—with each of your universities?

Dr. BROWN. —Colorado State University, depending on the circumstances, that is a possibility. Yes, we do not preclude an exclusive relationship with sponsors of programs. Again, we would look at all aspects involved in what is taking place.

But, yes, to answer your question, it can be done.

Mr. SIEVERS. At the University of Colorado it is also possible. In fact, we have some exclusive licenses today.

Mr. CORDES. And at Mines, the same is true.

So there you have it. You can keep it all.

There's a question in the back. Could you please identify yourself?

Mr. PLUNKETT. Excuse me, I'd like to speak for DU.

Mr. HIRSH. Oh, sorry.

Mr. PLUNKETT. DU gives you the patent, you do the licensing however you feel free?

[Laughter]

Mr. HIRSH. In the back there is a question. Could you come forward and identify yourself and your affiliation.

Mr. GORDON. My name's Tom Gordon, with Venture Quest Development.

I just wanted to ask the panel what specific programs do each of you have on a graduate level for technology transfer? Any graduate study programs in technology transfer. Do you have anything related to that at all?

Mr. HEARTH. I'm winging this a little bit, but I believe in our business school at the Boulder Campus there are some—one or more programs. It's not called technology transfer, but has a technology development flavor to it and so I'm sure it gets into the transfer question.

There is also a program, as I believe, in our Colorado Springs Campus, but that—that's really all I know about.

Mr. HIRSH. Jim?

Dr. BROWN. Yes, very similar to our College of Business, but it's not technology transfer per se but it does go into it. Otherwise, I'm not familiar with any other specific graduate programs.

Mr. HIRSH. John?

Mr. CORDES. I think that's essentially true. We're talking about the management of technology. There are programs in the management of technology, but not precisely in the art form of transfer of technology.

Mr. HIRSH. Any other questions?

In the back.

Mr. LEAHY. My name is Peter Leahy from Cell Technologies.

It sounds to me like most of what we've been talking about is collaborative research as opposed to technology transfer.

My understanding of technology transfer would be a holding house for all the technology which was being funded by the states, defense, and everyone else. My research, about 80 percent of that is still locked in the file cabinet somewhere. But there is a program being developed where technology is accessed by people who want it so they can come through and look through the lists and listen to things that are being done and say, hey, this is something we're interested in when we get in there, so we look at it.

Everything that I've been hearing this morning is, you come on in with your money and we'll do some collaborative research. There must be a lot of projects over the years that are really stuck in the file cabinets somewhere. How am I going to get access to that?

Mr. HIRSH. Jim.

Dr. BROWN. Yes, good point, and, for example, again, the display we have is technology that has already been developed and the faculty that have been involved, we have a booklet somewhere that lists technology development that has taken place.

And again, on the other point, we want to encourage you to come to our campus and visit with these faculty members that have the technology in their file cabinets and other things that exist. Because you are correct, there are many technologies that we feel quite positively exist on campus and we had trouble getting the faculty to come forward with that technology and make it available to the public.

Mr. HIRSH. I would point out one other thing in that.

There are documents available from the Government that list all grant applications, federal grant applications, and most of these institutions have supported most of this work that you would be trying to gain access to by federal grant money, which brings up another issue which I heard you say which I would like to correct.

It's true, it's not a free ride with the academic environment. Having been there myself I know full well that it's not. But there's nothing that catches the attention of an academic like a good idea, and most of you want access to the best people in the university.

Well, the best people in the university are extremely well-funded for their research, NSF, DOE, NIH, and what you want to do is catch their attention through the notion that you have, the idea. So it's not always gaining attention through paying for a piece of equipment or a graduate student.

Mr. HEARTH. David, I'd like to just comment.

I emphasize no free lunch because I wanted to—didn't want you people to walk out of here with the wrong impression, but I want to echo what David just said about getting the good person's attention. Because if you do that, then it can be a free lunch because he sees that mutual benefit.

On your point about a Cadillac of technology, as David pointed out, there's a lot of national data bases on technology that has found its way into the public domain in one form or another.

I want to again draw your attention to our business assistance center display back there because part of their job is to provide the access of companies like the ones represented in the audience to those national data bases. Now, that doesn't get into the file

drawer in the guy's head for stuff that has not been published. That requires the contact sport business.

Mr. HIRSH. I think there was one more question over here.

Ms. EYE. No, another comment.

Mr. HIRSH. A comment?

Ms. EYE. Just a brief comment in response to that question.

I'm with the CU Business Advancement Centers.

And in addition to access to the data bases that would have published research reports, we can also use the NASA research staff to gain access to the Federal Laboratory Consortium, to a network of experts in university research labs and in private laboratories to identify experts in the particular problem or application or question area that your business is looking for information in.

So, if you're interested in that, stop by our booth this afternoon and we'll glad to talk to you about it.

Thank you.

Mr. HIRSH. One question.

Mr. MARGOLIS. I'd like to share some resources, David, if I might.

The question had come up about information on technology transfer. There is a group called the Licensing Executive Society which publishes a quarterly bulletin called—the local contact point for that is Jack Hummel, who is Director of Patent Operations at Marathon Oil Company.

Also, with regard to technology access,—through the facilities of CSU the biotechnology development throughout the State has been catalogued and been made available through one of their professors. I'm not sure who that is, Dr. Brown, but all of the biotech information is available through CSU.

And finally, a question had come up previously about a conflict of interest with the university professor.

The Legislature of the State of Colorado did look into that in terms of passing some legislation in 1985. A panel was convened on that. The Legislature was convinced that that was a private contractual matter that should be left between the university and their staff, that the staff all had certain percentages of their time which they could devote to private research on their own, and that in the long run, it would be of the greatest benefit to the State for commercial developments to come to private industry, regardless of what the resource or the origin of that information was.

Mr. HIRSH. Thank you very much.

At this point I'd like to thank the panelists for their participation. I also would like to thank Congressman David Skaggs once again for organizing this and putting it together. I think it's an experiment that has shown some very positive results.

Mr. SKAGGS. Thanks, David.

[Applause]

Mr. SKAGGS. Thank you.

I hope the panel discussions—and I thank you all for participating—have served to warm everyone up for the real contacts which I think await during the afternoon sessions when you can go around and talk one-on-one with representatives of the Government Laboratories, university research efforts and start to make those individual kinds of contacts.

One thing that I simply don't know is whether included in your materials was any easy way to give us some comment and feedback and criticism of the day. If there wasn't and I don't believe I've seen it—if there is anything in the materials that were passed out, let me ask you please to do so.

We can only really get results from this experiment by hearing from you, whether it is worth repeating, how often, with what changes or whatever. And I would be pleased to try to be the catalyst for doing this again. If it's been useful or if it could be made more useful I certainly need to know.

There will be a directory of all of the conference participants available at the end of the lunch break, and I believe you already have a directory that was passed out of the firms and—excuse me, the labs and other activities that are represented for the poster sessions afterward.

Those are really the raw materials I think for turning this beginning into a real success.

Let me, again, pay special thanks to Cary Israel, Front Range Community College; Jack Keever, Adams County Economic Development Corporation; David Hirsh and Bob Sievers; and to all of you. We have an extraordinary set of resources in this part of Colorado. If we can put together a critical mass of interaction and sharing and growth, everyone is going to benefit tremendously. Let's make that happen after lunch.

By the way, lunch is courtesy of AT&T and the Colorado Community Colleges and Occupational Education System.

Thanks again for coming. Enjoy your lunch. Oh, lunches will be distributed at the tables that have been set up. I think I'm supposed to announce that those of you that have tickets for vegetarian plates should wave them in a conspicuous manner—

[Laughter]

—once you are seated.

And in the spirit of the day, don't sit with somebody you know. Sit with somebody that you think you might want to get to know.

Thank you a lot.

[Applause]

[Whereupon, at 12:05 p.m., the subcommittee was adjourned.]

APPENDIX

TECHNOLOGY TRANSFER CONFERENCE AGENDA

9:00 -- 10:00 a.m. (Terrace)
Registration and coffee

10:00 -- 10:10 a.m. (Coronado Room)
Welcome and remarks -- Congressman David Skaggs
"So What Do We Mean, A New Contact Sport?"

10:10 -- 11:00 a.m. (Coronado Room)
Panel -- Doing Business with Federally Funded Labs

Moderator: Dr. Robert Sievers, Director, Cooperative Institute for Research in Environmental Sciences, University of Colorado

Panel Members:
Dr. Bruce Mattson, Manager of Technology Commercialization and Small Business Outreach, NBS
Mr. Dana Moran, Manager, Research and Technology Applications, SERI
Dr. Vernon E. Derr, Director, NOAA Environmental Research Laboratories
Mr. Jeff Reaves, Senior Contracts Negotiator, NCAR
Dr. Bob Calcaterra, Director, Research and Development, Adolph Coors Quality Analysis Laboratories

11:00 -- 11:10 a.m.
Break

11:10 a.m. -- 12:00 noon (Coronado Room)
Panel -- Gaining Access to University and College Technology and Research

Moderator: Dr. David Hirsh, Executive Vice President and Director of Research, Synergen, Inc.

Panel Members:
Dr. Donald Hearth, Associate Vice President for Research, CU
Dr. Jim Brown, Assistant Vice President for Research and University Patent Officer, CSU
Dr. John Cordes, Dean of Graduate Studies, CSM
Dr. Jerry Plunkett, Vice Chancellor for Research and Technology, DU
Dr. Cary Israel, President, FRCC

12:00 noon -- 12:30 p.m. (Terrace)
Lunch

12:30 -- 2:00 p.m. (Juarez, Durango, Tijuana, and Coronado Rooms)
Technology Transfer Trade Fair
Featuring exhibits, demonstrations, and representatives from the labs, universities, and community colleges.

TECHNOLOGY TRANSFER:
a new contact sport

July 8, 1988
10:00 a.m. - 2:00 p.m.
Holiday Inn
I-25 and East 120th Avenue
Northglenn, Colorado

EXHIBITS AND DEMONSTRATIONS

THE NATIONAL BUREAU OF STANDARDS (NBS)

JUAREZ ROOM

NONDESTRUCTIVE EVALUATION: SENSORS FOR PROCESS AND QUALITY CONTROL

DR. VAN CLARK
NBS
DIVISION 430
325 BROADWAY
BOULDER, COLORADO 80303
497-3159

Electromagnetic and acoustic sensors are being developed for nondestructive materials characterization, flaw detection, and stress measurement. Use of a special noncontacting acoustical sensor is being explored for detection of flaws in railroad wheels (in a roll-by mode), on-line measurement of sheet formability, and residual stress characterization in drag-braked railroad wheels. A prototype acoustical array has been developed for real-time monitoring of degradation of material properties in composites. A capacitive array sensor uses the electric field to probe for defects in nonconducting materials; it is a possible monitor for curing of composites and ceramics. An eddy current probe has been developed for detection and accurate sizing of small flaws in metals.

FLUID PROPERTY DATA FOR INDUSTRIAL APPLICATIONS

DR. WILLIAM M. HAYNES AND DR. JAMES F. ELY
NBS
DIVISION 774.03
325 BROADWAY
BOULDER, COLORADO 80303
497-3247

Programs generate accurate data, in the form of interactive computer codes for industrial fluid mixtures. The data are used for both custody transfer and for process design and control. Important materials include aerospace gases, natural gas, supercritical solvents, refrigerants, and hydrocarbon mixtures.

BIOTECHNOLOGY AND CHEMICAL ENGINEERING APPLICATIONS

DR. SUBHAS K. SIKDAR
NBS
DIVISION 773.10
325 BROADWAY
BOULDER, COLORADO 80303
497-5232/5914

Much of the work in chemical engineering is focused on the space program and could be of interest to regional aerospace industries. The new biotechnology program is aimed at supporting the commercial processing, in large plants, of products based on biochemistry. The program emphasizes separation processes.

THE NATIONAL BUREAU OF STANDARDS (NBS)

JUAREZ ROOM

SUPPORTING INDUSTRY THROUGH ELECTROMAGNETIC MEASUREMENT SCIENCE

MR. GERRY R. REEVE
NBS
DIVISION 723
325 BROADWAY
BOULDER, COLORADO 80303
497-3557

Programs cover evaluation of rf and microwave devices, determination of electromagnetic properties of materials, characterization of antennas, measurement of electronic noise in systems and components, measurement of critical satellite and earth terminal parameters, and assessment of electromagnetic interference and immunity of systems.

OPTOELECTRONIC AND SUPERCONDUCTIVITY RESEARCH SUPPORTING U.S. INDUSTRY

DR. ROBERT A. KAMPER
NBS
DIVISION 104
325 BROADWAY
BOULDER, COLORADO 80303
497-3535

The program in optoelectronics supports developments in the areas of optical signal processing and optical communication including both optical fiber systems and integrated optics. Programs in large-scale and small-scale (electronic) applications of superconductivity are now looking at the new high-temperature superconductors.

OPTICAL AND ELECTRONIC TECHNOLOGY FOR LASER CONTROL AND APPLICATION

DR. KATHERINE B. GEBBIE
NBS
DIVISION 525
325 BROADWAY
BOULDER, COLORADO 80303
497-3527

Specialized instruments developed for use in fundamental research programs in atomic, molecular, and optical physics have potential applications in industry. Information developed in the course of basic work on lasers, gaseous electronics, and amorphous silicon also has direct applications in science and industry.

INTERFACING ACCURATE TIME AND FREQUENCY TO INDUSTRIAL SYSTEMS

DR. DONALD B. SULLIVAN AND DR. ROGER BEHLER
NBS
DIVISION 524
325 BROADWAY
BOULDER, COLORADO 80303
497-3772

Programs are aimed at efficient delivery of accurate timing and synchronization to both large networks (e.g., telecommunications, electrical power, and computer systems) and individual users. There are opportunities for industrial development of a wide variety of products to serve both industry and the general public.

THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH (UCAR) AND THE UCAR FOUNDATION

JUAREZ ROOM

UNIDATA AND NCAR GRAPHICS

DR. BEN DOMENICO
NCAR
UNIDATA PROGRAM
P.O. BOX 3000
BOULDER, COLORADO 80307
497-8631

The Unidata program (or Unidata) is a national program to help universities use computing and communication technologies to access, display, and analyze scientific data. Unidata is sponsored by the Division of Atmospheric Sciences of the National Science Foundation (NSF) and is managed by the University Corporation for Atmospheric Research (UCAR) through the Unidata Program Center in Boulder, Colorado. Unidata emphasizes partnership with universities. Unidata will provide software and help universities select and use computing and communication systems. Universities will help develop Unidata policies, provide technical assistance and software, and help define "data-broadcasting" services. This presentation will consist of two PC demonstrations of realtime weather data and satellite imagery: A) PC-Meidas is a display system which does not use NCAR Graphics, but reveals near-real-time satellite and weather data imagery and B) a weather processing and display system developed by Purdue University that serves as an enhancement to NCAR Graphics and GKS Graphics.

NCAR GRAPHICS

DR. ROBERT LACKMAN
NCAR
SCIENTIFIC COMPUTING DIVISION
P.O. BOX 3000
BOULDER, COLORADO 80307
497-1224

The NCAR Graphics package has been a major NCAR contribution in support of computing in the atmospheric sciences. It is a highly versatile set of utilities that are used widely in scientific computing. It has been distributed to over 1000 national and international organizations and has provided a basis for many spin-off graphical products. It is written in FORTRAN 77 and adheres to the Graphical Kernel System (GKS) and the Computer Graphics Metafile (CGM) standards, both of which are ANSI/ISO standards.

AIRPORT OF THE FUTURE

DR. WAYNE SAND AND DR. BILL MAHONEY
NCAR
RESEARCH APPLICATIONS
P.O. BOX 3000
BOULDER, COLORADO 80307
497-8654 OR 497-8826

The Airport of the Future concept involves incorporating the latest scientific knowledge and technology into an integrated terminal weather system to create a safer and more efficient aviation system. The development of the Terminal Doppler Weather Radar (TDWR) and recent enhancements to the Low-Level Wind Shear Alert System (LLWAS) are examples of technology that have been developed for the aviation community. Operational demonstrations of the LLWAS and TDWR systems at Stapleton International Airport at Denver in 1987-88 will be the principal focus of the exhibit.

THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH (UCAR) AND THE UCAR FOUNDATION

JUAREZ ROOM

ELECTRA DOPPLER RADAR (ELDORA)

DR. PETER HILDEBRAND
NCAR
ATMOSPHERIC TECHNOLOGY DIVISION
P.O. BOX 3000
BOULDER, COLORADO 80307
497-2050

ELDORA is the ELECTRA DOPPLER RADAR development project, a system that will transfer existing ground-based meteorological Doppler Radar capabilities to NCAR's Lockheed ELECTRA research aircraft. The principal purpose of the system will be for use by the atmospheric sciences community in a variety of programs related to the measurement of winds and turbulence within storms and clouds. It will also demonstrate the extent to which operational Doppler Radar can be expected to perform in commercial aircraft for the detection of low-level wind shear and turbulence.

CORPORATE AFFILIATES PROGRAM AND UCAR FOUNDATION

MR. JEFF REAVES
NCAR
SENIOR CONTRACTS NEGOTIATOR
P.O. BOX 3000
BOULDER, COLORADO 80307
497-8870

The Corporate Affiliates Program (CAP) was created by UCAR, providing significant opportunities for industry and business leaders to exchange knowledge with the research scientists at NCAR, the Institute for Naval Oceanography, and UCAR universities. This program is designed to bring to its corporate sponsors authoritative and objective assessments of the most advanced knowledge in the atmospheric sciences and clarification of controversial issues. Special emphasis is placed upon developing opportunities for joint ventures that have scientific and commercial benefit.

The UCAR Foundation, also created by UCAR, seeks to develops innovative and productive new relationships among the atmospheric and related sciences, government, and private industry to enhance the economic competitiveness of industry by expediting the transfer of scientific and technical advances into commercial applications. One of the Foundation's strategies has been to establish for-profit companies to develop technological and intellectual assets created by the UCAR community. To date the Foundation has incorporated two companies: Mesa Archival Systems, Inc. and the External Tanks Corporation. The Foundation is currently in the process of negotiating the incorporation of the Airport of the Future Project.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL RESEARCH LABORATORIES
(NOAA/ERL)

DURANGO ROOM

SPACE ENVIRONMENT LABORATORY (SEL) - THE SCIENTIST'S WORKBENCH

MR. DAVID SHAW
NOAA/ERL
325 BROADWAY, R/E/SE1
BOULDER, COLORADO 80303
497-5716

ERL's Space Environment Laboratory has developed an intelligent set of software routines that will permit a computer user, not programmer, to examine (and compare) "databases," both his/her own and those of others. The Scientist's Workbench effort is an attempt to design a consistent interface for all users, databases, and applicatons.

WAVE PROPAGATION LABORATORY (WPL)

MR. ROBERT T. FROST
NOAA/ERL
325 BROADWAY, R/E/WP
BOULDER, COLORADO 80303
497-6244

ERL's Wave Propagation Laboratory will present a three part exhibit describing:

1. The value of modern lidar technology in observing and studying environmental winds.
2. The opportunity for industry/federal laboratory cooperation to develop and procure remote sensing radiometers. The radiometers will operate in the 23.8 and 31.65 GHz frequencies to continuously measure atmospheric temperature.
3. The opportunity for industry to respond to new remote sensing concepts developed from federal laboratory theoretical studies. The example will be that of advanced optical filtering.

PROGRAM FOR REGIONAL OBSERVING AND FORECASTING SERVICES (PROFS)

MR. HERB GROTE
NOAA/ERL
325 BROADWAY, R/E 23
BOULDER, COLORADO 80303
497-6110

ERL's PROFS has developed a powerful real-time forecasting workstation that is based on the DEC VAXstation II/GPX and a Ramtek 9465. The software consists of approximately 100,000 lines of Pascal and FORTRAN code that runs under the VMS operating system. The workstation is known as SERS (Storm Education and Research System). PROFS will present a poster that will depict the various development activities that it is currently engaged in. Pictures and sketches will show the SERS (and other) workstations and some of the advanced sensors such as the Doppler radar that PROFS routinely uses at its workstations. PROFS will prepare a video tape that illustrates the functions, user interface, and general appearance of the SERS workstation.

SOLAR ENERGY RESEARCH INSTITUTE (SERI)

DURANGO ROOM

BUILDING ENERGY SCIENCE

MR. LARRY FLOWERS
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-1081

SERI's researchers are investigating materials, components, and systems that can reduce the energy use and cost for heating, cooling and lighting of buildings. These technologies include: desiccant cooling and dehumidification, indoor air quality/air flow management, high R windows, switchable glazings, phase change storage materials, active dhw systems, and building energy performance design and evaluation. The SERI capabilities in these areas include facilities and intellectual property that are state-of-the-art in the building sciences.

COMPACT VACUUM INSULATION

MR. TOM POTTER
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-1083

Two recent SERI inventions provide compact, highly insulating panels. One invention is a transparent, glass window glazing with predicted thermal resistance of more than R10. The other panel is made of steel and is predicted to have a thermal resistance of R15 in a thickness of only 0.1 inch. The compact, steel vacuum insulation panels are expected to find applications in refrigerators, freezers, and many other kinds of equipment where they would replace foamed polymer insulations presently made with chlorofluorocarbons (CFCs).

ATMOSPHERIC OPTICAL CALIBRATION SYSTEM

DR. ROLAND HULSTROM AND DR. TED CANNON
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-1220 AND 231-7247

SERI researchers have developed an economical and easy-to-use tool to measure the optical transmission properties of the earth's atmosphere. These data, which are available as real-time output, are used to determine the feasibility of outdoor testing of solar energy conversion devices that are spectrally sensitive (e.g., photovoltaic devices) as well as to measure solar spectra and optical progragation properties of the atmosphere.

SOLAR ENERGY RESEARCH INSTITUTE (SERI)

DURANGO ROOM

IMPROVED CELLULASE ENZYMES FOR FOOD AND SUGAR INDUSTRIES

DR. MEL TUCKER AND DR. ALI MOHAGHEGHI
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-7264 AND 231-7280

Studies in the production of alcohol fuels have led SERI researchers to the selection of an organism that will improve the yield and productivity of selected enzymes. This cellulase-secreting organism will have applications in processes requiring high heat, as in food preparation and sugar industries. Potential benefits include survivability of enzymes at the higher temperatures required for pasteurizing fruit juices and clarification of fruit juices, thereby reducing contamination and spoilage.

INNOVATIVE PHENOLIC ADHESIVES

DR. HELENA CHUM
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-7249

SERI scientists are investigating ways to use fast pyrolysis oils made from waste sawdust or bark in the SERI developed vortex reactor or other fast pyrolysis reactors. Phenolic compounds can be extracted from the pyrolysis oils using a SERI developed separation scheme. These phenolics can be employed to replace phenol and formaldehyde currently derived from petroleum. Such resins are used in the production of plywood, particle board, molding compounds, and insulation. The phenols could be produced for as little as one-third to one-half the average cost of petroleum-derived feedstocks, making a considerable savings in energy.

BIOMASS-TO-GASOLINE

DR. HELENA CHUM
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-7249

A non-alcoholic process to convert biomass to gasoline is being examined by SERI scientists. This process operates at atmospheric pressures and without the addition of hydrogen. High yields of organic vapors are obtained by the rapid, thermal decomposition of biomass in a continuous, chemical reactor using novel solid-convective heat transfer. These hot, organic vapors are immediately passed over a zeolite catalyst to form an aromatic gasoline, which could be used directly or, more suitably, as a high-octane blending stock.

SOLAR ENERGY RESEARCH INSTITUTE (SERI)

DURANGO ROOM

USER FACILITIES

MR. DANA MORAN
SERI
1617 COLE BOULEVARD
GOLDEN, COLORADO 80401
231-7115

SERI has more than 60 specialized laboratories and test operations. These facilities are available to industrial organizations and universities for the conduct of proprietary investigations and measurements at little or no cost.

COLORADO ADVANCED TECHNOLOGY INSTITUTE (CATI)

TIJUANA ROOM

MR. CHUCK HENNING AND MS. SUE MORGAN
555 - 17TH STREET, SUITE 2900
DENVER, COLORADO 80202
292-3640

CATI's job is to make the research resources of universities in Colorado available to Colorado businesses. CATI works with all the research universities and sponsors university-business programs. Information is available regarding CATI programs to facilitate technology transfer. CATI's programs are: The Advanced Materials Institute, The Colorado Institute for Artificial Intelligence, the Optoelectronic Computing Systems Center, SuperNet--the Colorado Computer Network, and The Colorado Institute for Research in Biotechnology. CATI is currently initiating a Small Business Innovation Grant Program.

COLORADO SCHOOL OF MINES (CSM)

TIJUANA ROOM

ADVANCED CERAMICS AND COMPOSITE MATERIALS

DR. GERALD DEPOORTER, ASSOCIATE PROFESSOR OF METALLURGICAL ENGINEERING
COLORADO SCHOOL OF MINES
1500 ILLINOIS
GOLDEN, COLORADO 80401
273-3954

The Colorado Center for Advanced Ceramics is a collaborative venture between Coors Ceramics Company and the school. Membership is open to other companies and universities with interests in the fields of advanced ceramics and composite materials. Through its seven laboratories, which perform every processing step from raw material preparation to final product development, the Center functions to improve technology transfer in these fast-paced fields and to foster continued growth of advanced materials companies in Colorado.

ENGINEERED MATERIALS PROCESSING

DR. GERALD DEPOORTER, DIRECTOR
ENGINEERED MATERIALS PROCESSING CENTER
COLORADO SCHOOL OF MINES
1500 ILLINOIS
GOLDEN, COLORADO 80401
273-3954

This Center addresses ceramic, metal, and polymer processing research needs for Colorado industry, with emphasis on timely technology transfer. The Center comprises one of the research labs within the Colorado Center for Advanced Ceramics.

WELDING AND JOINING RESEARCH

DR. STEPHAN LIU, ASSISTANT PROFESSOR OF METALLURGICAL ENGINEERING
COLORADO SCHOOL OF MINES
1500 ILLINOIS
GOLDEN, COLORADO 80401
273-3796

This facility is an internationally recognized center of excellence in all aspects of welding and joining research. It has direct interaction with numerous Colorado industries on widely varying metallurgical problems.

WASTE MANAGEMENT

DR. ANNETTE BUNGE, DIRECTOR, AND ASSOCIATE PROFESSOR OF CHEMICAL ENGINEERING AND PETROLEUM REFINING
COLORADO SCHOOL OF MINES
1500 ILLINOIS
GOLDEN, COLORADO 80401
273-3722

The Center is being developed to promote interdisciplinary research and education in the characterization and remediation of contaminated earth materials, including rocks, soils, and water. The Center will have active involvement with industry, government agencies, and other universities. It will promote technology transfer through publications, workshops, and seminars.

COLORADO SCHOOL OF MINES (CSM)

TIJUANA ROOM

HIGH-TEMPERATURE SUPERCONDUCTIVITY RESEARCH

MS. LESLEY OLERUD, ADVANCED MATERIALS INSTITUTE
COLORADO SCHOOL OF MINES
1500 ILLINOIS
GOLDEN, COLORADO 80401
273-3852

Research and development in superconductivity at CSM fall under two main headings: synthesis and processing, and analysis and characterization. Under study are superconductor-polymer composite materials, the manufacture of copper-clad wires, and conducting networks in the form of metal filaments and powders. Research in this area will complement ventures at the Colorado Center for Advanced Ceramics. The Advanced Materials Institute, a branch of the Colorado Advanced Technology Institute, provides essential support to the school's research thrust in superconductivity.

COLORADO STATE UNIVERSITY (CSU)

CORONADO ROOM

CURRENT RESEARCH AT CSU

DR. JIM BROWN
ASSISTANT VICE PRESIDENT FOR RESEARCH AND UNIVERSITY PATENT OFFICER
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523
491-7194

MS. KATHLEEN BYINGTON
VICE PRESIDENT, COLORADO STATE UNIVERSITY RESEARCH FOUNDATION
601 SOUTH HOWES STREET
FORT COLLINS, COLORADO 80523
482-2916

MR. JIM MAHONEY
CONTRACTS AND GRANTS ADMINISTRATOR FOR INDUSTRIAL SPONSORED RESEARCH
COLORADO STATE UNIVERSITY
FORT COLLINS, COLORADO 80523
491-6355

FRONT RANGE COMMUNITY COLLEGE (FRCC)

TIJUANA ROOM

DESKTOP PUBLISHING

MR. CLARK GERMANN, CHAIR OF COMMUNICATIONS DEPARTMENT
3645 WEST 112TH AVENUE
WESTMINSTER, COLORADO 80030 466-8811, EXT 370

Desktop publishing is a new technology that allows users to produce professional quality printed materials using a personal computer and laser printer. With desktop publishing, users can create high quality brochures, newsletters, advertisements, reports, resumes, and other materials. Visitors will be able to write text, scan and digitize artwork, and produce printed material using the equipment. This technology is particularly helpful for those involved in management or administration, marketing, public relations, research, and many other areas. Front Range Community College has the most comprehensive desktop publishing program in the area. During the past year, FRCC has spent more than a quarter million dollars on equipment to be used for desktop publishing.

CAD/CAM TRAINING CENTER

MR. JOE WUJEK, PROFESSOR OF ARCHITECTURAL TECHNOLOGY
3645 WEST 112TH AVENUE
WESTMINSTER, COLORADO 80030 466-8811, EXT 361

Front Range Community College's CAD/CAM Training Center presents the computer-aided drafting (CAD), computer-aided design (CADD), and computer aided-manufacturing (CAM) technologies available at the Center. Demonstrations will be presented in 2-D, 2 1/2D, and 3-D graphics. These include the following software packages:

AutoCAD -	2-E, 2 1/2D, CAD
CADVANCE-	2-D, 2 1/2-D, CAD
Auto-trol-	2-D, 3-D, CAD, CADD
Auto-trol-	NC programming, CAM

Demonstrations cover architectural and mechanical drafting and design, and numerical control programming.

FRONT RANGE COMMUNITY COLLEGE (FRCC)

TIJUANA ROOM

MEI NETWORK SYSTEM

MR. TOM GODWIN, EXECUTIVE PRESIDENT,
COMPLEXITY SIMPLIFIED, INC.
BOX 1028C
DENVER, COLORADO 80210 777-1122

Minority Enterprise Incorporated network (MEInet) enables fast and easy location of qualified minority suppliers while feeding the minority business enterprises' cash flow.

To list a bid or purchase order, a purchasing agent types information into the company's or agency's existing computer system or it can be typed directly into MEInet. Using a computer modem, the information is transmitted to MEInet via telephone lines.

To find bids or purchase orders, an MBE checks MEInet periodically on their company computer system, typing in keywords related to their business. Relevant bids are listed on the screen.

Colorado Alliance of Commerce and Industry network (CACInet) focuses on statewide businesses, resulting in enhanced small business cash flow through the same processes as described for MEInet. CACInet provides additional features such as job matching, work opportunities, and joint ventures that enable small businesses to join together to enable them to win the big jobs/bids.

UNIVERSITY OF COLORADO AT BOULDER (UCB)

TIJUANA ROOM

NEW SUPERCONDUCTOR MATERIALS AND PROCESSING

DR. ROBERT SIEVERS
COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES
CAMPUS BOX 449
UNIVERSITY OF COLORADO AT BOULDER
BOULDER, COLORADO 80309-0449
492-7943

New processes for preparing high temperature superconductors have been discovered. These processes have led to the synthesis of compositions not previously reported. C.U. scientists have learned ways to insert oxygen at temperatures as low as 150°C into oxygen-deficient perovskites to generate superconductors. The advance will greatly reduce inter-diffusion of ions that results when high temperatures are used for oxygen annealing, as encountered in present practice. A chemiluminescence instrument has been developed that allows sensitive monitoring of oxygen insertion. It has also been learned that the new superconductor materials can function as potent catalysts for redox reactions. This can be taken advantage of in new sensor technology as well as chemical manufacturing.

Further development of these superconductor processing techniques, including metal organic chemical vapor deposition (MOCVD) of thin films, will require a large investment of resources and cooperative effort by a major corporation that can carry this technology into the marketplace.

Other technologies being developed by Prof. Sievers and his group include oxygen separators, materials with unusual properties, chromatography detectors, and sensors. Prof. Sievers has been granted 21 U.S. and foreign patents and has other applications pending. Some of these have been licensed and others are available for license. Licensees include Kodak, Unocal, Aldrich Chemical Co., and Sievers Research, Inc.

*Collaborators in this R and D are S. Banning, R. Barkley, B. Hansen, B. Hybertson, B. McNamara, and S. Montzka.

COMMERCIAL APPLICATIONS OF ARTIFICIAL INTELLIGENCE

DR. JEFF RICHARDSON
COLORADO INSTITUTE FOR ARTIFICIAL INTELLIGENCE
CAMPUS BOX 419
UNIVERSITY OF COLORADO AT BOULDER
BOULDER, COLORADO 80309-0419
492-8229

The Colorado Institute for Artificial Intelligence (CIAI) promotes the development of technology and human resources in artificial intelligence for Colorado business and industry. One way CIAI achieves this objective is through the funding of relevant, small-scale applied research projects, each requiring collaboration between a Colorado university and a Colorado business. Five projects are underway, with twelve more starting in September. CIAI is a program of the Colorado Advanced Technology Institute, an agency of the State of Colorado. CIAI's members include all advanced degree granting institutions in the state and twelve Colorado businesses.

UNIVERSITY OF COLORADO AT BOULDER (UCB)

TIJUANA ROOM

TECHNOLOGY TRANSFER AT THE CU BUSINESS ADVANCEMENT CENTER (BAC)

MS. KAREN EYE
BUSINESS ADVANCEMENT CENTER
1690 38TH STREET, SUITE 101
BOULDER, COLORADO 80301
444-5723

The BRAIN (Business Research and Information Network) is a direct computer link to NASA Industrial Applications Center. NIAC with its expert researchers allows access to hundreds of national and international data bases, technical files, and expert contacts with federal labs, industry, universities, and private consulting firms. From the Boulder office and the 16 BRAIN Associate Centers throughout the state, businesses, industry, and individuals choose from over 1200 public and commercial data bases to obtain information in over 400 major categories. Where computerized information cannot be found, a national expert consultant is obtained, free of charge to BAC clientele.

OPTOELECTRONIC COMPUTING SYSTEMS

MS. CAROL HIGGINS
CENTER FOR OPTOELECTRONIC COMPUTING SYSTEMS
CAMPUS BOX 525
UNIVERSITY OF COLORADO AT BOULDER
BOULDER, COLORADO 80309-0525
492-7967

The Optoelectronic Computing Systems Center is the focus for a sustained national effort in optoelectronics. By joining academe and industry in an experimental effort, OCA aims to combine the best of both worlds, swiftly moving innovations into the marketplace. The Center, directed by W. Thomas Cathey, brings together computer architects, optics researchers, digital signal processing experts, and specialists in sophisticated optical materials and devices from both the University of Colorado (CU) and Colorado State University (CSU).

The Center functions much like an industrial research laboratory, but is distinguished by a strong educational focus. Its objectives are:

- Developing optoelectronic devices and systems for computing, signal processing, and artificial intelligence.
- Preparing students for careers in optoelectronics.
- Transferring technology efficiently to U.S. industry.

Emphasizing the development of demonstration hardware as well as device research, the Center offers students an appreciation for intricacies of systems design and analysis. Its graduates will leave equipped with a unique breadth of hands-on experience.

UNIVERSITY OF COLORADO AT BOULDER (UCB)

TIJUANA ROOM

ADVANCED DECISION SUPPORT FOR WATER AND ENVIRONMENTAL SYSTEMS

DR. KEN STRZEPEK
CENTER FOR ADVANCED DECISION SUPPORT FOR WATER AND ENVIRONMENTAL SYSTEMS
CAMPUS BOX 428
UNIVERSITY OF COLORADO AT BOULDER
BOULDER, COLORADO 80309-0428
492-3971

The Center for Advanced Decision Support for Water and Environmental Systems was established in September 1986 in the College of Engineering and Applied Science, University of Colorado at Boulder, as a Center of Excellence for the purpose of applying artificial intelligence techniques to water and environmental decision making. CADSWES is associated with the Center for Applied Artificial Intelligence, College of Business, University of Colorado at Boulder, and the Center for Artificial Intelligence (theoretical research), College of Engineering and Applied Science, University of Colorado at Boulder.

CADSWES has a full-time director and staff dedicated to applied research and development of advanced decision support systems. Being housed in an academic setting combined with a full-time staff allows for the production of deliverable, state-of-the-art systems and the ability to provide excellent training programs. In addition, the Center has an industry/government/academic advisory board to assure the quality of the work and the direction of the research.

CADSWES was recently selected as the Bureau of Reclamation's National Center for Research and Development of Advanced Decision Support Systems. The selection for this four-year, $4,000,000-plus grant was based on a nation-wide competition.

UNIVERSITY OF COLORADO AT BOULDER (UCB)

TIJUANA ROOM

RESEARCH IN ENERGY MANAGEMENT

MS. KAREN GEORGE
JOINT CENTER FOR ENERGY MANAGEMENT
CAMPUS BOX 428
UNIVERSITY OF COLORADO AT BOULDER
BOULDER, COLORADO 80309-0428
492-3915

The Joint Center for Energy Management is a collaborative effort of the colleges of engineering at Colorado State University and the University of Colorado. Funded by the State of Colorado, Center programs focus on the design and technology of cost-effective, energy-efficient buildings and industrial processes, as well as application of renewable resources. The Center has four primary missions:

1) technical assistance to Colorado business, industry and government;
2) research and development of heating, ventilating and air conditioning (HVAC) systems and other building and energy-related technology;
3) professional development programs in building sciences, energy engineering, and other topics;
4) enhanced undergraduate and graduate training in energy engineering.

The Center's exhibit emphasizes three of its major projects: an Energy Analysis and Diagnostic Program that provides free technical energy audits to Colorado businesses; a new HVAC laboratory co-sponsored by industry; and the Weather Network, a climatic data collection system and reporting service.

89-158 0 - 88 - 3

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER (UCHSC)

DURANGO ROOM

DOPPLER ULTRASOUND FOR MEDICAL APPLICATIONS

Dr. AL J. MICCO AND MS. STACY STORY
UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
CARDIOVASCULAR PULMONARY LABORATORY
4200 EAST 9th AVENUE
BOX B133
DENVER, COLORADO 80262
270-7411

A unique Doppler ultrasound system for medical application has been developed by the bioengineering group of the CVP Laboratory. The system is capable of measuring blood flow velocity in vessels throughout the body at depths ranging from 0.5cm to 18cm. The system operates at four transmit frequencies (2 MHz, 3.5 MHz, 5MHz, and 7MHz) in either pulsed or continuous mode. It is user friendly; all electronic functions (transmit power, filter selection, gain correction, etc.) are selected automatically when a probe is chosen for specific measurements. The signal to noise ratio (typically 200 to 1 at the common carotid artery with a transmit power of 25mw/cm^2 of crystal area) is greater for a given transmit power than any other commercially available instrument. Three output signals are provided by our Doppler Signal Processor on-line and in real-time (pat. pending): (1) the velocity distribution of the red cells, (2) the instantaneous mean of the velocity distributions, and (3) the quadrature audio signals that contain the above information. Signals 1 and 2 are normally processed on-line by computer. Signal 3, the quadrature audio signals that contain all of the Doppler information, can be recorded directly on Phillips cassette tape for off-line processing.

Presently we are in the process of refining computer algorithms and generating new programs to compute velocity distribution histograms, systolic time intervals, volumetric blood flow, noninvasive assessment of pulmonary artery pressure, and other measurements in support of our on-going research in the CVP laboratory.

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER (UCHSC)

DURANGO ROOM

BIOLOGICAL STRUCTURE AND FUNCTION: MASS SPECTROMETRY

DR. PAUL V. FENNESSEY AND DR. ROBERT C. MURPHY
UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
SCHOOL OF MEDICINE
DEPARTMENTS OF PEDIATRICS AND PHARMACOLOGY
4200 EAST 9TH AVENUE
BOX C232
DENVER, COLORADO 80262
394-7286/7287 OR 397-8962

Services Available

Instruments: A VG Micromass MM-16 with electron impact and chemical ionization source, capillary and packed gas chromatographic inlets, and a foreground/background data system. A Nermag R10-10C fitted with a capillary gas chromatograph as well as CI and EI ionization. This instrument is used mostly for negative ion chemical ionization studies. A VG Micromass 7070E-HF high-resolution mass spectrometer fitted for EI/CI and FAB ionization. Medium mass capability m/z 2600 at full acceleration potential of 6 kv. A Hewlett Packard 5970 (MSD) fitted with a capillary gas chromatograph and an automatic injector.

Service Personnel: Instruments and data system operation are carried out by facility personnel. Users are encouraged to participate in the analysis and interpretation of data.

Research Emphasis or Application:

Data Achievable with Resource's Methodologies: Quantitative analysis of drugs and/or natural metabolites found in physiological fluids. Separation, identification, and quantitation of chemically different classes of compounds (e.g., prostaglandins, organic acids, steroids, CNS compounds, etc.)

Current Research: Investigation into the synthesis, metabolism, and quantitative analysis of cyclooxygenase and lipoxygenase pathway compounds. These methods are used to evaluate the physiological roles of these important compound classes in healthy and diseased states. Identification of steroid profiles and steroid biotransformations in normal individuals and in patients with biochemical (inborn errors) and pathological irregularities. Measurement of the dynamics of the metabolism of important biochemicals such such as sugars, amino acids, etc. Evaluation and development of a modified FAB (dry target) method for the analysis of trace metal isotopes. Preliminary studies using the techniques on adults, premature and lactating patients are in progress. Effect of ethanol and neuroleptics on biogenic amino synthesis in the central nervous system.

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER (UCHSC)

DURANGO ROOM

QUANTITATIVE CONSULTATION AND SERVICE

DR. JAMES R. MURPHY AND DR. WILLIAM R. BRAITHWAITE
UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
DEPARTMENT OF PREVENTIVE MEDICINE AND BIOMETRICS
4200 EAST 9th AVENUE
BOX B119
DENVER, COLORADO 80262
270-5170 OR 270-5169

The University of Colorado School of Medicine Department of Preventive Medicine and Biometrics specializes in the quantitative aspects of research. We provide courses on topics such as research methods, biostatistics for clinical trials, and how to meet FDA requirements for medical device manufacture. We consult in a variety of quantitative areas with roots in epidemiology, biostatistics, and informatics, including the design, implementation, and analysis of population studies, technology assessment programs, survey instruments, computer systems and databases, artificial intelligence programs, and clinical trials. We also provide services in some less quantitative areas such as program evaluation and medical ethics. Our occupational medicine specialists can evaluate and/or implement programs providing for the health care needs of your workforce. If you have need of outside service or would like to explore joint research in these areas, please stop by our table and chat or contact us by phone.

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER (UCHSC)

DURANGO ROOM

COMPUTER GENERATED 3-DIMENSIONAL HUMAN ANATOMY REVEALED BY MODERN CLINICAL IMAGING MODALITIES

DR. VICTOR M. SPITZER, DR. DAVID G. WHITLOCK, MS. RENEE A. TORGLER, MR. KYLE NICKEL
UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
DEPARTMENTS OF CELLULAR AND STRUCTURAL BIOLOGY AND RADIOLOGY
4200 EAST 9th AVENUE
BOX B111
DENVER, COLORADO 80262
270-8791 OR 270-8201

With the emergence of powerful new clinical imaging methods such as computed x-ray tomography (CT), magnetic resonance imaging (MRI), and real time ultrasound, the amount of internal anatomy of the patient that can be visualized non-invasively has been greatly increased. This morphology can be imaged in any plane and its visualization provides extraordinary opportunities for evaluating structures situated deep in the human body that heretofore could not be seen. In order to identify and interpret this new anatomy, unique methods have been devised for the preparation of ultra-thin serial macroscopic sections of the body, which, in turn, provide a data base for computer generated 3-dimensional reconstructions of anatomical regions. Through the use of animation and computer pseudocolor techniques, anatomical features of special interest can be encoded in vivid color within the 3-D reconstructions so that the details of the internal anatomy can be easily interpreted. This program therefore provides a basis for visualizing internal human anatomy for purposes of improved clinical diagnosis, research, and teaching.

UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER (UCHSC)

DURANGO ROOM

A MINIATURIZED QUADRUPOLE MASS SPECTROMETER FOR CARDIOPULMONARY STUDIES AND MONITORING

DR. AL J. MICCO AND DR. GEORGE D. SWANSON
UNIVERSITY OF COLORADO HEALTH SCIENCES CENTER
CVP LABORATORY AND DEPARTMENT OF ANESTHESIOLOGY
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A special miniature mass spectrometer for use in cardiopulmonary studies and monitoring has been developed. It is portable, computerized, and self-contained and can be used in a variety of studies and for monitoring in a space environment. A fast response time (35 ms) combined with a high degree of accuracy was obtained by developing a special direct inlet system. The gas is sampled directly from the respiratory valve and immediately conducted (1 ms delay) into the ionizer through a servo-controlled inlet. To further improve the system, a high performance electron bombardment ionizer was developed. The small ionization volume (.2 cc) provides a rapid speed of response. The efficiency of the ionizer is maximized by the use of a special focusing system for both electron beam and the incoming gas molecules. The mass filter is a specially designed quadrupole with a delayed DC-ramp that provides high resolution and stability. A solid state electrometer amplifier with a target ion pickup is employed as a detector, and can be used with an electron multiplier for sensitivities in the 5ppb range. A flowmeter (hot-wire anemometer) and a fast response temperature sensor are incorporated into the mass spectrometer system for the purpose of measuring total volumetric flow rate. The Quadrupole filter is programmed by a micro-processor that selects a different gas species every 2 ms (i.e., ten gases that are user selectable are sampled every 20 ms).

This system is ideally suited for single breath and breath-to-breath analysis of physiological and tracer gases. Developed software includes routines for determining pulmonary blood flow and tissue volume, CO_2 and O_2 kinetics during exercises, ventilatory threshold, and breath-to-breath alveolar O_2 consumption and CO_2 production. The system has also been used for anesthesia uptake studies and tracer gas studies of lung function.

UNIVERSITY OF DENVER (DU)

TIJUANA ROOM

CURRENT RESEARCH AT DU

DR. JERRY PLUNKETT
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UNIVERSITY OF DENVER
DENVER, COLORADO 80208-0100
871-2626

TECHNOLOGY TRANSFER:
a new contact sport

July 8, 1988
10:00 a.m. - 2:00 p.m.
Holiday Inn
I-25 and East 120th Avenue
Northglenn, Colorado

Information on Participating Institutions

THE NATIONAL BUREAU OF STANDARDS (NBS)

The National Bureau of Standards was established by an Act of Congress in 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides:

- A basis for the Nation's physical measurement system;
- Scientific and technological services for industry and government;
- A technical basis for equity in trade; and
- Technical services to promote public safety.

NBS has laboratories in Gaithersburg, Maryland and Boulder, Colorado organized in four major operating units: the National Measurement Laboratory (NML), the National Engineering Laboratory (NEL), the Institute for Materials Science & Engineering (IMSE), and the Institute for Computer Sciences and Technology (ICST). The Boulder programs are conducted in the following seven divisions.

FRACTURE AND DEFORMATION DIVISION (IMSE)

The staff of this division conducts basic research on the deformation and fracture of materials and applied research directed toward improving structural safety and industrial productivity. Division work contributes to an understanding of materials and provides a basis for selection of materials for service applications.

TIME AND FREQUENCY DIVISION (NML)

The principal functions of this division are to produce and maintain the standards of time and frequency and coordinate them internationally; to provide time and frequency services for the Nation; and to perform research and development on new time and frequency standards and measurement methods.

QUANTUM PHYSICS DIVISION (NML)

This division is part of the Joint Institute for Laboratory Astrophysics, a cooperative project with the University of Colorado. Programs in this division involve long-term research in fundamental and precision measurements, geophysical measurements, atomic and molecular physics, chemical physics, and astrophysical measurements.

ELECTROMAGNETIC FIELDS DIVISION (NEL)

This division conducts basic and applied research on the interaction of electromagnetic radiation with devices and materials. The work emphasizes development and evaluation of measurement methods and standards needed to characterize the mechanisms and output of electromagnetic sources, receivers, and other devices.

ELECTROMAGNETIC TECHNOLOGY DIVISION (NEL)

This division develops measurement techniques and standards and provides calibration services and reference data for laser and fiber optics metrology and for engineering applications of superconductivity. Programs include the application of superconductivity to new electrical and electronic measuring techniques.

THE NATIONAL BUREAU OF STANDARDS (NBS)

THERMOPHYSICS DIVISION (NEL)

This division focuses on the thermophysical properties of fluids important to the chemical industries. Division outputs include new measurement techniques, thermodynamic models, and molecular theories to describe the behavior of condensed matter. Critically evaluated data on thermophysical properties is also developed.

CHEMICAL ENGINEERING SCIENCE DIVISION (NEL)

This division performs basic and applied research for reactor design and for unit operations such as mass transfer, heat transfer, and separations. The division develops the data bases and measurements that underlie the performance of chemical processes and solid materials important to the chemical industries.

THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH (UCAR) AND THE UCAR FOUNDATION

NCAR GRAPHICS - LICENSING AND DISTRIBUTION

NCAR Graphics is a sophisticated graphics software package, designed primarily to provide scientific, engineering, and technical graphics capabilities and displays on a variety of computer systems. Three versions are currently available: GENERIC (which is not machine-specific), UNIX, and VAX/VMS. The UCAR Foundation currently licenses the unsupported software to commercial entities, and has also embarked on a campaign to license several software developer/distributors to produce fully supported commercial products for use on computer systems ranging from PCs to supercomputers.

NCAR MASS STORAGE/ARCHIVAL SYSTEM

The NCAR Mass Storage System (NCARMSS), which has been used at NCAR since March, 1986, currently has the capability of moving about two trillion characters of information each month in a heterogeneous computing environment. In 1987, the UCAR Foundation created Mesa Archival Systems, Inc., to modify and market NCARMSS as a commercial product.

LOW-LEVEL WIND SHEAR ALERT SYSTEM (LLWAS)

Deployed by the FAA, the LLWAS is the only ground-based wind shear detection system currently operating at airports in the U.S.; it is planned to be installed at 110 airports. The system utilizes surface wind speed and direction sensors to measure the presence of wind shear--rapid changes in speed or direction--over the airport.

TERMINAL DOPPLER WEATHER RADAR (TDWR)

Beginning in the mid-1980s, the FAA began development of a program designed to bring Doppler radar to the nation's major airports. Research associated with several projects conducted at NCAR in the last few years indicated that Doppler weather radar is significantly more capable in detecting microbursts than previous Doppler radar technologies. The radar can detect the horizontal outflow of a microburst as well as scan aloft to detect microbursts in their formative stages. Operational testing of TDWR in July, 1988, if successful, will lead to the production of approximately 100 TDWRs nationwide, ready for installation between 1992 and 1994.

NCAR RADIOSONDE DEVELOPMENT

NCAR plans to develop for the National Weather Service a simple, semi-automatic radiosonde system to upgrade atmospheric soundings and substantially reduce costs. The new system uses a LORAN navigator to provide accurate measurement of winds where LORAN is available and an OMEGA/VLF navigator for the island stations and other sites without LORAN coverage.

ELDORA AIRBORNE DOPPLER RADAR

ELDORA is the ELECTRA DOPPLER RADAR development project being conducted by the Atmospheric Technology Division of NCAR. This system will transfer existing ground-based meteorological Doppler Radar capabilities to NCAR's Lockheed ELECTRA research aircraft. The principal purpose of the system will be for use by the atmospheric sciences research community in a variety of programs related to the measurement of winds and turbulence within storms and clouds.

THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH (UCAR) AND THE UCAR FOUNDATION

POLYPAINT

PolyPaint is a scientific software package currently being developed within NCAR that is capable of displaying various scientific variables, as well as data sets, in 3-dimensional color graphics and polygonal contour surfaces. NCAR anticipates that it will ultimately be licensed to end-users and developer/distributors in a manner similar to the NCAR Graphics package.

EXTERNAL TANKS CORPORATION

The External Tanks Corporation was created by UCAR to promote, develop, and manage SPACE PHOENIX, an effort to recycle and add value to the expended external fuel tanks (ETs) of the Space Shuttle System, and then see them used for a variety of scientific and commercial purposes.

VISUALIZATION GRAPHICS

Staying at the leading edge of computing technology is part of UCAR/NCAR's strategy for being able to address new opportunities in science and for increasing the rate of scientific progress. As an example of such technology development, UCAR/NCAR recently entered into an agreement with Digital Equipment Corporation (a UCAR Corporate Affiliate member since 1985) to develop methods of visualization through graphics of scientific models, computational fluid dynamics, and networking.

AIRPORT OF THE FUTURE

The Airport of the Future project, supported by the UCAR Foundation, seeks to analyze the potential effects of weather on the operation of the new international airport to be built at Denver, Colorado, in the early 1990s. The goal of this project is to create the world's safest and most efficient airport by incorporating available scientific knowledge and technology into a totally integrated terminal weather system.

SOLAR ENERGY RESEARCH INSTITUTE (SERI)

The Solar Energy Research Institute (SERI) is the national center for federally sponsored solar energy research and development. Established by Act of Congress in 1977, the Institute is a government-owned, contractor-operated federal laboratory of the Department of Energy. SERI is managed for DOE by the Midwest Research Institute of Kansas City, Missouri.

SERI is the Department of Energy's principal laboratory for basic and applied research in the solar conversion technologies. The Institute undertakes exploratory studies, experimentation, and testing in its own facilities and supports contracted R&D with industrial organizations and universities throughout the country. Because all of SERI's research is intended for eventual commercial application, technology transfer is a major objective of the Institute.

SERI's research is conducted by three divisions in nine technical areas:

SOLAR ELECTRIC RESEARCH DIVISION

Photovoltaics - Development of innovative concepts, materials, and structures to improve the efficiency and economics of solar cells.

Wind Energy - Aerodynamic and structural research, environmental impact studies, and performance analysis of wind turbine systems.

Resource Assessment - Characterization of the solar radiation and wind energy resources, including data collection, modeling, and instrumentation.

SOLAR FUELS RESEARCH DIVISION

Biofuels - Research in photochemistry, electrochemistry, thermochemistry, and biotechnology to discover new and innovative methods for the conversion of biomass, municipal wastes, and biological sources to liquid and gaseous fuels.

SOLAR HEAT RESEARCH DIVISION

Solar Thermal Energy - Development of materials and systems for converting solar thermal energy to process heat and electricity for industry.

Solar Buildings - Studies of thermal energy management and daylighting in residential and commercial buildings.

Building Energy R&D - Research in thermodynamics, energy flows, and ventilation in residential and commercial buildings.

Energy Storage - Development of innovative thermal energy storage systems.

Ocean Energy - Development of materials, components, and systems for converting ocean thermal energy to electricity.

Total SERI staff is approximately 510, including an average of 80 visiting researchers, graduate students, and temporary employees. About two-thirds of the staff are research professionals. SERI research funding in FY1988 is approximately $55 million.

COLORADO ADVANCED TECHNOLOGY INSTITUTE (CATI)

As an Agency of the state of Colorado, CATI's job is to make the research resources of universities in Colorado available to Colorado businesses. CATI works with all the research universities and sponsors university-business programs. Information is available regarding CATI programs to facilitate technology transfer. CATI's programs are: The Advanced Materials Institute, the Colorado Institute for Artificial Intelligence, The Optoelectronic Computing Systems Center, SuperNet--the Colorado Computing Network, and the Colorado Institute for Research in Biotechnology. CATI is currently initiating a Small Business Innovation Grant Program.

COLORADO SCHOOL OF MINES (CSM)

"COLORADO SCHOOL OF MINES: MUCH MORE THAN ITS NAME."

This slogan is indicative of the diverse nature of the school's educational and research programs. Researchers at CSM are currently working on 100 high technology projects which will have application in the near future. CSM provides a broad range of technology transfer, special programs, and continuing education opportunities.

Mines plays a major role in providing Colorado, the nation, and the world with skilled engineers and scientists. The school's comprehensive educational approach gives CSM students a unique combination of technical ability, environmental sensitivity, managerial and leadership skills, and applied research experience. Mines graduates serve throughout the world in such fields as satellite resource analysis, design of robots for ocean bed mining, design of advanced materials, advanced mining systems, and vapor geochemistry.

CSM offers B.S. degrees in ten major areas: geology and geological engineering, geophysics, chemistry and geochemistry, mining engineering, petroleum engineering, metallurgical engineering and materials science, chemical engineering and petroleum refining, engineering physics, mathematics, and engineering (electrical, mechanical and civil options). In addition, CSM offers the M.S. degree in thirteen fields and the Ph.D. degree in eleven areas. Professional degrees are also offered in mining, petroleum, geophysics, and geology.

The school has identified seven major research thrust areas that provide American industry with research support and leadership. These areas include research in exploration sciences, extraction and refining, manufacturing systems, fuels science and thermodynamics, the environment, and international programs. Active Centers of Excellence on campus number thirteen and include the Colorado Center for Advanced Ceramics, the Institute for Ground Water Research and Education, the Center for Wave Phenomena, the Center for Welding and Joining Research, and the Institute for Energy Resource Studies. Ten other Centers are now under development.

For practicing professionals, the Office of Special Programs and Continuing Education provides many opportunities to augment and upgrade knowledge and skills through special programs, short courses, and teacher enhancement programs.

CSM has maintained its dedication to quality education, research, and public service for over 100 years. The school's 2,350 gradute and undergraduate students represent 50 states and 67 foreign countries. CSM alumni serve in industry, government, and education in all parts of the world.

COLORADO STATE UNIVERSITY (CSU)

ANIMAL REPRODUCTION LABORATORY

Animal reproduction research at Colorado State is at the forefront of its field. The University developed the procedures used throughout the world for embryo transfer and embryo cloning in cattle and horses. Colorado State exists as one of the few places with the expertise and equipment to inject isolated genes into ova or one-cell developing embryos.

CENTER FOR COMPUTER ASSISTED ENGINEERING (CCAE)

Computer assisted engineering (CAE), design (CAD) and manufacturing (CAM) facilities provide support to campus research and educational programs. The Robert Anderson Laboratory within the Center contains state-of-the-art engineering and graphic workstations networked to additional computing resources. Research focuses on advanced design concepts, expert systems, graphical display, and the rapid translation of design to manufacturing.

FOOD RESEARCH AND DEVELOPMENT CENTER

The objective of the Center is to provide technical assistance related to food processing, product development, acceptability, and marketing to individuals and firms in Colorado. This activity will further develop the food processing industry in Colorado, add value to Colorado-grown agricultural commodities, and contribute to economic growth in the State.

SUPERCOMPUTING RESEARCH AND EDUCATION

Recognizing the necessity of large-scale, ultra-high speed digital computing to model many scientific devices and natural phenomena, Colorado State was the first U.S. university to obtain a Cyber 205 supercomputer (two vector computing pipelines, two million word memory with appropriate peripheral equipment). The University provides vector and parallel processing support. Colorado State is extending the use of the supercomputer to other universities and industry nationwide via a high-speed data network. Other available computing resources include Cyber 825 and 835 systems and a variety of computing apparatus located campus-wide.

TISSUE CULTURE FOR CROPS PROJECT LABORATORY (TCCP)

Established to utilize emerging tissue culture technologies to promote the development of stress-tolerant crop plants, the TCCP already has seven productive years' experience as an established facility. Selected in 1984 for a multi-million dollar U.S. Agency for International Development project, TCCP conducts research of a global nature, trains crop specialists from more than 15 foreign countries, and maintains an international information network on plant biotechnology.

VETERINARY TEACHING HOSPITAL

A concern for health and the diseases of animals and humans provides the unifying theme for the undergraduate, professional, and graduate programs of the College of Veterinary Medicine and Biomedical Sciences. Work in the areas of immunology, virology, radiation biology, cancer research, genetic engineering, micro-anatomy, and structure of living organisms provides the foundation of a strong program in basic biological research.

FRONT RANGE COMMUNITY COLLEGE (FRCC)

Celebrating its 20th anniversary this year, Front Range Community College offers more than 50 degree and occupational programs. During graduation ceremonies in May, 800 students received degrees or certificates, enabling them to transfer to four-year universities or begin their careers. Last year, the College introduced the Associate of Science degree in Hazardous Materials Technology and the Associate of Arts degree in Technical Writing and Editing.

The College offers a broad range of student services including continuing education, learning disabilities assistance, college via television and several sites for off-campus study. Also, through an agreement between the Colorado Consortium for International Programming and the American Institute of Foreign Study, students may study at the University of London. Customized training is an important role for the College, serving such companies as IBM, AT&T, Gerico, UPS, Ball Metal, Public Service of Colorado, Miniscribe, and many others. The College is also involved with a Small Business and International Development Center, which offers free counseling and other services to business owners and assists in developing international markets.

To encourage students to begin their college careers at the community college level, the Colorado Community College and Occupational Education System announced agreements between Colorado's two-year and four-year colleges for the General Education Core Transfer Program. This program is a significant link in the continuum for educational opportunity. These agreements ensure transferability to students who want to meet the lower division general education requirements at the community/junior college level. This formal agreement will become effective this fall.

Other programs the College offers are courses in desktop publishing, computer-aided drafting and computer-aided machining, interpreter training, nursing, an agreement with Ford Motor Co. to train their future automotive employees, and many other speciality areas.

Additionally, the College takes pride in its sister college, Takayama College in Japan. Delegates from Takayama chose Front Range because of its auto mechanics and business programs. The entire College community is looking forward to a visit from several Takayama College students this month.

Front Range Community College is pleased to welcome the Larimer County Vo-Tech Center at Ft. Collins as a part of the Front Range system. This transition will enable students to earn associate degrees in Fort Collins, and will take place over the next two years.

TECHNOLOGY TRANSFER:
a new contact sport

DIRECTORY OF CONFERENCE ATTENDEES

July 8, 1988

Conference sponsored by:
Congressman David Skaggs
Front Range Community College
Adams County Economic Development, Inc.

Conference Presenters:
National Bureau of Standards
National Center for Atmospheric Research
National Oceanic and Atmospheric Administration
Solar Energy Research Institute
Colorado Advanced Technology Institute
Colorado School of Mines
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PANEL MEMBERS AND PRIMARY TECHNOLOGY TRANSFER CONTACTS
AT
PARTICIPATING ORGANIZATIONS

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